

From Knowledge to Invention: Exploring User Innovation in Irish Agriculture

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ABSTRACT

Improvements in European agriculture are framed in the literature as arising from an Agricultural Knowledge and Innovation System with innovations provided by others for farmers to adopt. The motivators for farmers who invent useful products for themselves, without outside involvement, are not well understood in such developed countries. These inventions, often shared with other farmers rather than introduced to the market, arise from a process of user innovation (von Hippel, 2005). This thesis examines Irish farmers' motivators in the creation and subsequent sharing or commercialisation of farming artefacts. Their motivators are conceptualised from a sociological perspective, using Bourdieu's theory of capitals (1986). Employing a multi-perspective research design, methods include a content analysis of 210 inventions, semi-structured interviews with key informants from innovation support organisations, and in-depth interviews with farmer-inventors. The findings indicate that most farmer-inventors get great personal satisfaction from problem-solving and, being generally without higher education, use their tacit knowledge to create inventions that increase efficiency as a means to improve family farm viability. Despite efficiency usually indicating skilful farming, Irish farmer-inventors are frequently derided by other farmers who deem their inventing to be culturally inappropriate. Farmer-inventors with entrepreneurial intentions, willing to withstand such hostility, face financial and temporal constraints, while the help offered by innovation support organisations is often inadequate. As a result, some inventions with commercial potential may never reach the market. Farmer-inventors who share their knowledge and inventions in social learning networks, similar to communities of practice, accrue social capital that leads to the emergence of a shared farmer-inventor identity. This thesis contributes to knowledge about user innovation in developed country agriculture by offering deeper understandings of farmer-inventors' social, cultural, and economic processes. It proposes farmers to be an underappreciated source of knowledge and inventions, which offer low cost farm-level solutions to support family farm resilience.

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I dedicate this thesis to my late parents, Nell and Gerry O'Flynn.

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Chapter 1 – Introduction

1.1 Introduction

In 1986, an Irish farmer invented a mechanical feeder that served warmed cow's milk, on demand, to calves after weaning. He tested it on three farms and found that the health and weight gain of the calves improved when his feeder was used. He believed that the machine would be of benefit to other farmers, so he took it to his local dairy co-op and some government agencies. They were not interested; they either ignored his evidence or told him to go away and test the feeder with a larger sample under scientific conditions (Shutes, 2003, p. 68).

This story resonated with me, when I came across it in 2012, as I completed my Master's degree in Public Advocacy and Activism at the National University of Ireland, Galway. My thesis was on rural protest, looking at the relationship between identity-based and emotional factors and people's motivations to mobilise. I used the turfcutters' dispute with the Irish government, over the designation of certain bogs as Special Areas of Conservation (SAC) which required the cessation of turf cutting, as my case study. Two of my findings were, first, that the designation process for SACs excluded those most affected and, second, that it granted scientific knowledge exclusive status in the process over farmers' tacit knowledge, i.e. knowledge and practices gained through a lifetime of working on the bog (O'Flynn, 2012, p. 46). Shutes' story suggested to me that the apparent low standing of farmers' knowledge in environmental governance regimes might be replicated in agricultural research and was worthy of further study. In 2014, coincidentally, I met the farmer who invented the calf feeder at an agricultural show, where he had entered his latest idea in the invention competition. He agreed to join this research study as an interview participant and, as we shall see below, his disappointment at cultural and organisational attitudes towards inventing farmers is still current, thirty years later.

In this opening chapter, I begin by setting out the economic and cultural context for Irish agriculture in which this study takes place. I then set out the aim of this research, which leads to the identification of the overarching research question and a number of research sub-questions

(RSQ). Following this, I describe the theoretical framework and the research design that responds to these questions, and then present the contributions to knowledge that arise from the findings of this study. I finish by outlining the structure of the thesis and identify the chapters where the different research sub-questions are addressed.

From this point onwards I use the term ‘farmer-inventor’ to denote a farmer who takes their invention into the public domain, i.e. beyond the farm gate. Please note, also, that for the purpose of clarity in-text citations are *italicised*, with emphases in **bold**, throughout this thesis.

1.2 Research Context

1.2.1 The Agricultural Context

Global agriculture faces major demographic, environmental, and economic challenges. The most recent population forecasts suggest that, while population growth overall is predicted to slow (OECD-FAO, 2016, p. 17), world food demand will increase by 60 per cent by 2050 (Alexandratos and Bruinsma, 2012, p. 7). The outlook for agriculture will also be influenced by the demand for non-food production, such as bio-fuels (Alexandratos and Bruinsma, 2012, p. 5). Constraints on agricultural production, such as land and water availability, mean that increasing production, in order to ensure food security, will require increased economic, social, and environmental sustainability.

In a competitive global market, where agricultural products are treated as commodities, the European Union’s (EU) Common Agricultural Policy (CAP) has been through a number of transitions since its inception in post-war Europe in 1957. Within a broader economic approach that encourages competition and the removal of barriers to trade, the CAP has adopted measures to protect and support agriculture that are both costly and controversial. Funding for the CAP comprised just over 70 per cent of the total EU budget in 1980, 62 per cent in 1990, around 50 per cent in 2000, and just under 40 per cent, some 52 billion Euros, in 2014 (European Commission, 2016a, p. 1).

From an early protectionist policy that encouraged agricultural productivity, with resulting damage to the environment, and the later introduction of support for rural development more generally, the most recent reforms in 2013 shift the focus from *“product to producer support and ... a more land-based approach”* (European Commission, 2013, p. 2). The aim is to address issues of competitiveness and sustainability, leading to a sustainable intensification of agricultural production and the development of the wider rural economy, including balanced territorial development. This means a joint emphasis on the provision of public (such as biodiversity and landscape) and private goods (European Commission, 2013, p. 5), through the removal of production constraints, increased producer co-operation, and targeted help for small farmers to reduce administrative burdens and support diversification into alternative enterprises (European Commission, 2013, p. 9). The CAP is monitored annually using a set of 45 context indicators that were developed for rural development programmes, in order to measure general economic, environmental, and social trends in the programme area. The metrics use statistical data, with no qualitative or cultural indicators.

In this policy context, the European Commission (2015a, p. 61) forecasts a decline of 3 per cent in total agricultural income in Europe between 2015 and 2025, as costs continue to outstrip the value of production. However, an increase in agricultural income of 16 per cent in real terms per labour unit is also forecast, mainly due to reduced labour costs as a result of farm restructuring and mechanisation.

In Ireland, a member of the European Union (EU) since 1973, family farms account for 99 per cent of all farms (Eurostat, 2015, p. 18), slightly higher than the EU average of nearly 97 per cent (Eurostat, 2015, p. 12). The average Irish farm size is 35 hectares, similar to Belgium (34 hectares), but smaller than the United Kingdom (UK) (92 hectares) and France (58 hectares) (Eurostat, 2016, p. 34). One difference between Ireland and the UK is the number of farmers who own their land. In England nearly two thirds of farmland is owned (Department for Environment, Food and Rural Affairs, 2014, p. 1), compared to around 84 per cent in Ireland (Society of Chartered Surveyors Ireland, 2015, p. 14). Yet Irish and UK farmers operate in the same EU policy and market

environment and over 75 per cent of holdings in each country are mechanised (i.e. have tractors; European Commission, 2016b, p. 7).

The trend across the EU has been for farming subsidies to go mainly to large farmers and this is no different in Ireland where *“it is now clear that both price measures and structural measures disproportionately benefitted those farmers who already owned the most resources – put simply, the more you had, the more you got”* (Crowley, 2006, p. 30). Crowley (2006, p. 35), a sociologist, argues that this imbalance in the distribution of support is undemocratic and unjust, as the majority of farms are small, and that most farmers in Ireland *“muddle through ... making the most of their circumstances and using whatever assets they can to ensure their survival”* (p. 66). Member States have some discretion in how they implement the CAP changes and, at the time of writing (July, 2017), Ireland had no specific small farm support scheme in place.

Agriculture, dominated by small family farms, is expected to play an important role in Ireland’s recovery from the post-2008 economic recession. The Food Wise 2025 Agri-food Strategy sets ambitious targets to be achieved by 2025, including increasing the value of primary production by 65 per cent and agri-food exports by 85 per cent (Department of Agriculture, Food and the Marine, 2015, p. 10). The strategy also calls for the creation of additional jobs in the agri-food supply chain, including in primary production. Family labour provides over 90 per cent of the work carried out in Irish agriculture (Eurostat, 2016, p. 46) and, in contrast to the majority of EU countries, Ireland reported an increase in the agricultural labour force, between 2005 and 2013 (Eurostat, 2015, p. 65), probably due to the contraction in off-farm work during the recession. This resulted in a drop in agricultural income of 17 per cent per labour unit over the same period (Eurostat, 2015, p. 66), with implications for farm viability.

In 2015, the percentage of Irish farm households classified as economically viable through farming income was 37 per cent, the same as in 2014, with the remaining 63 per cent having non-viable farm businesses (Hennessy and Moran, 2016, p. 3). In the same study, farm households deemed viable due to off-farm income were at 29 per cent, with 34 per cent of farm

households classified as economically vulnerable with a non-viable farming business and no off-farm income (Hennessy and Moran, 2016, p. 3). Viability varied greatly between types of farm enterprises and regions of the country, with dairy farms being the most profitable and farming in the border region of the country the least viable (Hennessy and Moran, 2016, p. 3-4). Achievement of the Food Wise 2025 strategy's targets will require support for sustainable intensification of production, adoption of new technologies, and skills development across all farm types and sizes.

European policy for agricultural research and innovation is increasingly calling for the participation of farmers in the co-creation of knowledge and there are a number of organisations in Ireland, formal and informal, whose policies and practices aim to support agricultural research, education, advice, and innovation. In this thesis, I conceptualise the relationships between farmer-inventors and these organisations as an Agricultural Knowledge and Innovation System (AKIS), see sub-section 1.3.1 and Chapter 2 below. Ireland's farmers and institutions are subject to powerful historical and cultural conventions, which are considered next.

1.2.2 The Irish Historical and Cultural Context

Ireland gained its independence from Britain in 1921 and, building on earlier land reforms, land purchase schemes cemented in place *"the farmer's rigorous attachment to his land"* (Brown, 1985, p. 29). This deep attachment to the land has been described as *"the defining feature of Irish cultural history"* (Smyth, 2001, p. 10, original emphasis), with the rural being *"elevated above the urban"* as a sign of Irish identity (Smyth, 2001, p. 36). This is borne out in the levels of land ownership in Ireland (currently 84 per cent), well above the EU average, reversing that of the colonial era when, in 1880, the share of land rented by farmers was 96 per cent (Society of Chartered Surveyors Ireland, 2015, p. 14).

Small family farms symbolise *"a purity and decency of life"* (Varley, 2009, p. 145), and Byrne and O'Mahony (2012, p. 53), paraphrasing Arensberg and Kimball's seminal 1930s study of Irish rural life, found they were *"sustained and maintained by an expectation of the exchange of family*

labour, resources, and support based on the reciprocal obligations of kinship ties". While the small family farm has been central to Irish identity, the more recent Celtic Tiger period (1993-2008 approximately) of rapid economic growth saw a modern Irish identity emerge that was confident, forward looking, European, and consumerist (Smyth, 2012, p. 132) that claimed to be *"liberated from the limitations of the past"* (Kirby, 2010, p. 105). However, a strong rural identity persists: recent graduates who grew up on Irish farms retained a farming identity even after moving to urban settings (Cassidy and McGrath, 2015, p. 27).

The 1960s saw the demise of rural political parties and of farmers as a political class, bringing about an increase in clientelism, whereby politicians do favours for constituents in return for votes (Varley, 2010, p. 594). Irish political culture has been described as one that *"encourages people to see that state as a body from which goods are to be extracted with the aid of intermediaries"* (Górecki and Marsh, 2014, p. 12) and as *"authoritarian, conformist, and anti-intellectual"* (Coakley, 2009, p. 55). Although community development approaches have promised rural people greater involvement in decision-making (McDonagh, 2001, p. 203), Ireland remains a centralised state, with considerable power held by a *"state bureaucracy that has been less than open and user friendly"* (Górecki and Marsh, 2014, p. 12). This short scene-setting suggests that continuing economic pressures and an opaque political and institutional culture offer mixed prospects for Ireland's farmers, the majority of whom make no profit from their farming businesses. This highlights the importance of resilience strategies for the survival of small family farms and it is from this context that the research aim emerged.

1.3 Research Aim and Research Questions

1.3.1 Research Aim

This study explores user innovation in Irish agriculture. User innovation is a relatively newly theorised phenomenon in the business literature whereby *"users create and modify products and services to serve their own needs, and often make these innovations freely available to each other"* (Flowers et al., 2010, p. 4). User innovation in agriculture has not been studied in more

developed countries and the business literature, often based on surveys, does not address the subjectivities of the inventor in any depth. My research aim, therefore, is to contribute to addressing that gap in the literature and to contribute to knowledge by investigating farmers' inventing activities, including their economic, social, and cultural motivators, the invention process and its outputs, and the networks of relationships involved.

I focus my data collection on those farmers who have invented tangible artefacts, rather than processes, services, social or institutional innovations (see sub-section 2.3.1 below), for two reasons. The first reason relates to the gap in the literature identified above, in that this research builds on the extant literature relating to farming artefacts and processes in less developed countries, and incorporates the academic literature on knowledge and innovation. Rural social and institutional innovations, on the other hand, are not currently as well studied and this research starts to build our understandings of farmers' artefactual invention processes, which may be usefully applied to other types of rural innovation in the future. The second reason is pragmatic; farmer-inventors of tangible artefacts are more visible due to the physical nature of the invention. This is important for a time limited PhD study with field work in another country, although I find that farmer-inventors are not widely visible in Irish rural society, as we shall see later.

The farmers' networks of relationships with formal and informal organisations are conceptualised as an Agricultural Knowledge and Innovation System (AKIS). I use the AKIS as a framing device to approach these relationships from the perspective of farmer-inventors in order to invert the standard model and look at what might be missing, i.e. farmers' own knowledge, inventions, and networks. This in turn leads to two areas of critical examination, first, of farmers' knowledge and inventions as, perhaps, a neglected resource and, second, the potential modifications required to the AKIS to accommodate all types of knowledge and invention. This approach also supports my commitment to investigate the outcomes for those people affected by policy decisions by making the farmer-inventors' perspective the central narrative of this thesis. This investigation also complements my Master's research, which gave prominence to

farmers' knowledge and practices relating to turf cutting and the bog environment, by focusing on another facet of farmers' knowledge and skills: inventing.

1.3.2 Research Questions

The above research aim is addressed in the following overarching research question:

How do the motivators of Irish farmers influence their approach to the invention process and what are the outputs and the learning communities involved?'

The research sub-questions (RSQ) provide a focus for the research design, which is discussed in the next section:

- RSQ1: What are the characteristics of farmer-inventors?
- RSQ2: How do farmers approach the invention process?
- RSQ3: To what extent are farmer-inventors motivated by economic, social, and cultural factors?
- RSQ4: Do farmer-inventors have entrepreneurial intentions for their inventions?
- RSQ5: To what extent do the ties between farmer-inventors and their informal networks represent a social learning community?
- RSQ6: What is the state of the farmer-inventors' relationships with the formal organisations in the Irish Agricultural Knowledge and Innovation System?

1.4 Theoretical Framework and Research Design

1.4.1 Theoretical Framework

In this thesis I focus on farmer-inventors' subjectivities, as well as the inventions themselves, through consideration of economic, social, and cultural factors. I do this by applying user innovation theory (von Hippel, 2005) to provide a comparison between user innovation in agriculture and the other business sectors studied to date. I also apply Bourdieu's theory of capitals (1986), from the sociological literature, to analyse how Irish farmers' inventing behaviour

is influenced by the economic, social, and cultural context in which they are situated. As stated above, I frame my investigation of the relationships between farmers and innovation support organisations using the Agricultural Knowledge and Innovation System (AKIS) model to allow me to problematise issues of innovation and knowledge in the AKIS, which I investigate through the perspective of farmer-inventors. I discuss the academic literature relating to these theories in Chapter 2.

1.4.2 Research Design

The research design consisted of consecutive stages of data collection whereby the data and analysis from earlier stage(s) fed forward to influence the subsequent approach and build cumulative insights in relation to the research questions. I combined a quantitative content analysis with in-depth qualitative interviews in an extended period of fieldwork (April 2014 – November 2015).

I approached this research project as a “*shared space*” (Bourke, 2014, p. 1), influenced by myself and the research participants: our experiences, identities, and biases. I shared the interview transcripts with the participants for their comments at the analysis stage, and then updated them at the findings stage in order to elicit further feedback. The research design, including researcher reflexivity, is presented in detail in Chapter 3 below.

1.5 Contribution to Knowledge

This thesis contributes to both the user innovation and sociological literatures, by firstly, extending user innovation theory and, secondly, supporting and reinforcing Bourdieu’s (1986, p. 253) theoretical positions relating to capital conversion strategies. These are set out in detail in Chapter 7. In relation to user innovation theory I propose the following extensions:

- tacit knowledge, not higher education alone, is a rich source of knowledge and skills for user innovation;

- exposure of an idea to peers does not always result in useful feedback that improves the idea or encourages its commercialisation, it can have the opposite effect;
- inventions from a business endeavour may not be shared as freely as those from hobbyist user-innovators;
- user innovation networks may also contain dimensions of community that lead to identification between members.

In relation to Bourdieu's theory of capitals (1986, p. 253) I propose the following insights on the capital conversion strategies pursued by farmer-inventors:

- farmers' values and emotions, which motivate their inventing behaviour, are influenced by the social structures within which they operate;
- the decision to take an invention into the public domain, given restrictive social and cultural norms, is the key turning point in the farmers' invention journey;
- the free sharing of inventions, which allows access to the resources of others, is a long term strategy suited to farmer-inventors who are situated in their locality;
- commercialisation of the invention is a high risk strategy, made more perilous for the farmer by the lack of appropriate help from innovation support organisations.

1.6 Thesis Structure

This section briefly outlines the contents of each of the chapters in this thesis. In summary, Chapter 2 presents the review of the literature, while Chapter 3 focuses on the research methodology, including the development of the theoretical framework. Three empirical chapters follow: Chapter 4 presents the findings of the content analysis of British farmers' inventions and Chapter 5 and 6 the interviews with Irish farmer-inventors. Chapter 7 summarises the findings and sets out theoretical implications, while Chapter 8 draws together the discussions and makes policy and practice suggestions.

Turning to the chapters in more detail, in Chapter 2, in consideration of the relational settings of farmers' inventing, I start by critiquing representations of the Agricultural Knowledge and Innovation System (AKIS) conceptual model, including Irish examples. This provides the setting for the problematisation of innovation and knowledge that follows. I then review the literature relating to user innovation and the motivators for farmers' own inventions. I discuss different interpretations of innovation in the business and design literatures, then focus on the extant user innovation literature and how it relates to traditional understandings of innovation and entrepreneurship. Next I consider farmers' experiments and inventions, as presented in the international development literature. I identify a gap in the intersection of these literatures as discussed in 1.3.1 above. The invention process involves the combination and recombination of knowledges, and I discuss how the business and sociological literatures approach different types of knowledge and issues of status. I discuss, through the lens of a social theory of learning, how farmers' knowledge is generated and shared through their networks. I then consider the sociological literature relating to the economic, social, and cultural factors that might influence a farmer's inventing behaviour. I discuss how entrepreneurial intentions must be considered alongside social and cultural motivators that may spur or inhibit user innovation in agriculture. In Chapter 3 I set out the research design for the study, the choice of data sources, and analytical approaches. In the first part of the chapter I present a qualitatively-led methodology, including how Bourdieu's sociological theory of capitals (1986) articulates with what are essentially economic understandings of user innovation (von Hippel, 2005). In the second part of Chapter 3, I present the sequential research design and conclude with a short discussion of researcher positionality and the ethical approaches taken to the data collection.

In Chapters 4, 5, and 6, I present the findings from the data collection as they relate to the research sub-questions (RSQ). Chapter 4 deals with the content analysis of 210 inventions, mainly from British farmers, which featured in Practical Farm Ideas magazine. It identifies certain characteristics of those farmers (RSQ1), their approach to the invention process (RSQ2), and the extent of free sharing of inventions (RSQ5) in that context. There is no similar source of

information about Irish farmers' inventions and I go on to discuss the relevance of these findings to the scoping of the subsequent stages of data collection in Ireland.

Chapters 5 and 6 present the findings of the interviews with farmer-inventors and key informants in the Irish AKIS. In Chapter 5, I consider the economic and cultural factors involved in farmers' inventing. These relate to farmers' values (RSQ3), economic motivators and commercialisation of inventions (RSQ4), farmer-inventors' knowledge and skills (RSQ1), and the response of other farmers to their inventing (RSQ3). In Chapter 6, I describe the structure and membership of, and the sharing of resources and inventions within, farmer-inventors' networks (RSQ5), the farmer-inventors' interactions with the formal organisations in the Irish AKIS (RSQ 6), and present the farmers' approach to inventing as a design process (RSQ2).

In Chapter 7 I firstly summarise the key findings from the research, organised by research sub-questions 1-6 and offer a perspective on British and Irish farmers' inventions. In the second part of the chapter I synthesise the analysis from Chapters 4, 5, and 6 to identify significant findings as they relate to my theoretical framework, i.e. user innovation theory (von Hippel, 2005) and Bourdieu's theory of capitals (1986). I close the chapter by reflecting critically on those theories used in this thesis. In the concluding chapter (Chapter 8) I discuss the implications of the theoretical contributions for European and Irish agricultural and innovation policies and make suggestions for practice, based on my own and the farmer-inventors' insights. I then outline some limitations of the study, my personal learning points, and suggestions for how this research might be extended through further studies. We now turn to the literature review.

CHAPTER 2 – Review of the Literature on User Innovation, Knowledge and Learning Communities

2.1 Introduction

2.1.1 Opening Remarks and Key Definitions

The aim of this chapter is to review the literature on user innovation and the learning communities that surround it, with a focus on the process of user innovation in agriculture and its outputs in the form of farmers' inventions. While most of the research to date on user innovation is overwhelmingly from the economic and business disciplines, often based on survey methods, there is little exploration of user innovation in agriculture. Equally, the international development and farming systems literature consider farmers' inventions, often using participatory methods, but mainly in less developed countries, a very different context to Irish agriculture. My research aim, therefore, is to contribute to addressing those gaps in the literature and to contribute to knowledge by investigating farmers' inventing activities, including their economic, social, and cultural motivators, the invention process and its outputs, and the networks of relationships involved.

A study of user innovation using sociological theory might suggest potentially competing epistemological understandings of the process of user innovation. Marra et al's (2003, p. 216-7) review of technology adoption literature arising from the economics and sociology disciplines, found that sociological approaches had lost their dominant position due to their focus on relational factors and a failure to adopt economic modelling approaches which give greater emphasis to economic variables. They distinguished between the approaches by stating that economists consider *"economic variables were the major determinants of technological change"* (p. 217), while sociologists were focussed on the *"distinguishing characteristics [and] perceptions of potential adopters and opinion leaders ... and the communication channels involved"* (p. 216). Notwithstanding these differences, I approached the research design as a means to analyse user innovation in agriculture from multiple perspectives, see sub-section 3.2.1 below.

I start this literature review by setting out some key definitions, then the context in which the farmer-inventors operate, using the Agricultural Knowledge and Innovation System model referred to in Chapter 1. The review then considers, from economic, social and cultural viewpoints, different categorisations of innovation, along with farmer-inventors' motivators and experimentation, in order to present a more holistic and rich understanding of the phenomenon of user innovation in agriculture. The aim is to present a multi-faceted picture of the economic, social, and cultural dimensions of farmers' inventions and the learning communities from which they arise. The acquisition and sharing of knowledge by farmer-inventors is considered in the context of a social theory of learning and positions knowledge, and the technology arising from it, as socially constructed (Kline and Pinch, 1996, p. 765). The review concludes by identifying some gaps in the literature that inform this thesis.

2.1.2 Key Definitions

Before commencing this literature review, it is important to set out some key definitions that apply throughout this thesis, I define:

- 'farmer' as it is used by the Irish government for legal purposes: *"A 'farmer' is defined as a natural or legal person, or a group of natural or legal persons, who undertakes agricultural activity, regardless of size or income"* (Department of Agriculture, Food and the Marine, 2016, p. 15). This definition is appropriate to the context and sufficiently broad to capture all types of farming activity. Additionally, the inclusion in the definition of a group of people reflects the importance of farm family labour to Irish farming activities, which may include inventing;
- 'farmer-inventor' as a farmer who takes their inventions into the public domain. I acknowledge that many farmers will invent useful items yet not take them beyond the farm gate. For the purposes of this study I am interested in those who do;
- 'invention' as: *"something new that did not exist before or doing something in a new way, a way that has not been done before in a particular context"* (after Jörg and Akkaoui

Hughes, 2013, p. 222). This means that the farmer may not be the first to have the idea, but it is the first time in their particular setting;

- ‘innovation’ as it is usually found in the business literature: *“Innovation is the first commercialization of the idea”* (Fagerberg, 2003, p. 3). Although there are other understandings of the term, which are contested, it suits my purpose here. A separate case is user innovation which incorporates the free sharing of inventions, thus commercialisation is not necessary for a user innovation to be considered a success;
- ‘community’ and ‘network’ as Wenger (2010, p. 10) suggests, in that they can co-exist in the same social structure, relating to identity (community) and connectedness (network);
- ‘tillage’ is the term used in the Irish context, officially and colloquially, for the farming of cereals and is used throughout this thesis.

2.2 The Agricultural Knowledge and Innovation System

This section’s discussion follows Chapter 1’s presentation of the agricultural, historical, and cultural context of the Irish AKIS and focuses on the academic literature relating to the Agricultural Knowledge and Innovation System (AKIS) concept. In this thesis the AKIS acts only as an analytical tool to frame the farmers’ perspective of their interactions with formal and informal organisations involved in farming research, advice, and innovation support. The remaining sections of this chapter discuss the literature on innovation, knowledge, and economic, social, and cultural motivators for invention. Taken as a whole, they provide a means to critically examine related issues, such as knowledge status, understandings of innovation and social exchanges in the AKIS, which in turn lead to the research questions.

2.2.1 Evolution and Definition of the Concept

Agricultural research, advice, and education systems have evolved through a number of conceptualisations since the 1960s (Röling and Engel, 1990, and others globally). This section deals with the AKIS concept as operationalised in the European context, of which Ireland is part,

and therefore draws on the European Commission's Standing Committee on Agricultural Research's reports on the AKIS in Europe (EU SCAR, 2012, 2013, and 2016) and related Europe-wide projects, e.g. PRO AKIS. In an extensive review of the literature to inform the PRO AKIS project, Labarthe et al. (2013, p. 27) identify two main frameworks used to describe knowledge flows in agricultural systems. These approaches have evolved from the top-down transfer of technology model embodied in the Agricultural Knowledge System and are, currently, known as the Agricultural Knowledge and Innovation System (AKIS) and the Agricultural Innovation System (AIS).

The AKIS, emerging from the more participatory Agricultural Knowledge and Information System, broadens the focus beyond the transfer of knowledge and information to adopt a networked approach for mutual learning between farmers and other actors. The AKIS approach is described as *"both constructivist and proactive"* (EU SCAR, 2012, p. 23) and is linked to themed Learning and Innovation Networks for Sustainable Agriculture (LINSAs), which generate *"learning and innovation through interactions between the involved actors"* (EU SCAR, 2012, p. 25). However, the AKIS approach is not without its critics. Knickel et al. (2009, p. 137) set out the arguments in the context of the transition to a more systemic approach: some find the AKIS to be a productivist intervention that promotes linear knowledge transfer, which has become less relevant in light of increasing fragmentation of the system following restructuring and privatisation of public sector providers. Knickel et al. (2009, p. 142) also find that others argue its relevance has increased, as the interconnectedness between agricultural practices, rural development, and environmental impacts means the AKIS approach is well placed to help integrate policy making and implementation. Others criticise the lack of concrete outputs, such as new technologies. Notwithstanding this, the AKIS has been adopted by the EU Standing Committee on Agriculture as a model to describe the European agricultural innovation system.

Concurrently, the AIS framework identifies opportunities for enhancing the innovation capacity of agricultural systems, recognising institutional and wider economic, social, cultural, and technological contexts. A key intervention is the 'innovation platform', a multi-actor approach

that includes farmers and which provides opportunities for collective innovation. A complex and dynamic but not always smooth process, it aims to produce social and economic benefits (Kilelu et al., 2013, p. 75). The AKIS and AIS concepts are different but co-exist and sometimes overlap (Labarthe et al., 2013, p. 5). For the purpose of this thesis, with its emphasis on farmers' knowledge and the inventions that embody it, farmer-inventors' interactions with formal organisations are framed in the AKIS tradition.

Lane and Oreszczyn (2013, p. 2) find the AKIS to be comprised of *“organisations and individuals, linked and interacting through networks who are engaged in creating, sharing, and using different types of knowledge to support innovation in agriculture”*. The co-production of knowledge, learning, and innovation in the AKIS represents a paradigm shift from an interventionist model that sought to increase technology adoption and productivity, to a farmer-driven approach aimed at sustainable development (Rivera et al., 2005; Emtage et al., 2007; Davis, 2008).

In face of changing policy, environmental, and technological contexts, the EU SCAR (2016) has published a foresight document to consider options for the future organisation of agricultural innovation in Europe. The report draws on the findings of the recent EU PRO AKIS project, which mapped and analysed the diverse features of the AKIS in different European countries from the perspective of advisory services or *“the entire set of organisations or activities that enable farmers to co-produce farm-level solutions by establishing service relationships with advisors so as to produce knowledge and enhance skills”* (Labarthe et al., 2013, p. 10). The PRO AKIS inventory noted that the increasing plurality in organisations offering advice to farmers challenges the effectiveness of long established means of communication, particularly to farming subgroups (e.g. small farmers, new entrants), and suggests *“there is a growing necessity to develop new horizontal and vertical linkages and frequently to coordinate knowledge flows beside purposeful steering and government activities”* (EU SCAR, 2016, p. 105). Having considered a range of different scenarios, and based on an assumption that there will be further significant restructuring in agriculture, the foresight report concludes that the current AKIS

structures are not fit for future purpose and that *“the role of actors within the AKIS, the interaction between subsystems and with other themes, AKIS policies etc.”* be reviewed (p. 119) and makes a number of recommendations. Of interest here are those recommendations relating to farmers’ interactions with the AKIS. Given the plurality of providers, it calls for better signposting to support farmers to find sources of advice and recommends the setting up of a quality certification system (p. 120). The report also acknowledges farmers as creators of knowledge (p. 9) and proposes research funding be reoriented to innovative transdisciplinary research, with a focus on bottom-up research, or *“innovation in the wild”* (p. 121), and identifies that the involvement and accommodation of the diverse needs of farmers could be achieved through the European Innovation Partnership (EIP) model (p. 121).

The EIP for Agricultural Productivity and Sustainability was launched in 2012 and seeks a shift from top-down science-led models to bottom-up participatory approaches. The aim is to connect agricultural research with farm practice in interactive research and innovation processes (EU SCAR, 2013, p. 55). The EIP model involves regional or national multi-actor problem-focused Operational Groups, which may potentially organise in EU-wide thematic research networks. To date several thematic networks have been set up to research sector-specific and cross-cutting issues, including support for high nature value farmlands and controlling disease in the wine sector. Building where possible on current arrangements, the EIP is expected to make the Agricultural Knowledge and Innovation System (AKIS) more responsive to current economic and environmental challenges (EU SCAR, 2013, p. 7).

In relation to agricultural research the EIP model takes a broad definition of innovation in that it may be *“technological, non-technological, organisational or social...based on new or traditional practices. Innovation may lead to commercialisation, if commercialisation occurs at all”* (EU SCAR, 2013, p. 26). In this way the EIP potentially opens up the agricultural knowledge and innovation system to user and social innovations, although the most recent EU strategy on agricultural research and innovation (European Commission, 2016c, p. 29) still views farmers as co-creators, with others, of knowledge. The strategy views farmers’ tacit knowledge as

something to be harnessed by experts in the open innovation mode (p. 28). In this way, farmers are viewed only as problem identifiers rather than active problems solvers and knowledge creators in their own right. The EU strategy would appear to be at odds with the EU SCAR's (2016) vision for the AKIS presented above. The following sub-section briefly examines the European AKIS model, as it is currently presented (EU SCAR, 2012, 2013), in order to discuss the organisational settings in which farmer-inventors operate. This, in turn, will frame the data relating to farmer-inventors' interactions with the formal organisations in the AKIS in Chapter 6.

2.2.2 A Model Agricultural Knowledge and Innovation System

This section examines an idealised diagrammatic model of the AKIS, presented in Figure 2.1 (EU SCAR, 2012, p. 26), which shows interactions between the system and its environment, as well as between sub-systems. Viewed from the systems perspective the AKIS is a *“set of components interconnected for a purpose”* (Lane, 2002, p. 40), which has *“properties that derive from the interactions of its parts that none of its parts have”* (Ackoff, 2001, p. 343). These properties include intangibles, such as assumptions, norms, relationships, and behaviours (Lane, 2002, p. 42). In considering the extent to which the relationships in the AKIS diagram operate as indicated, some important omissions from the model are also identified.

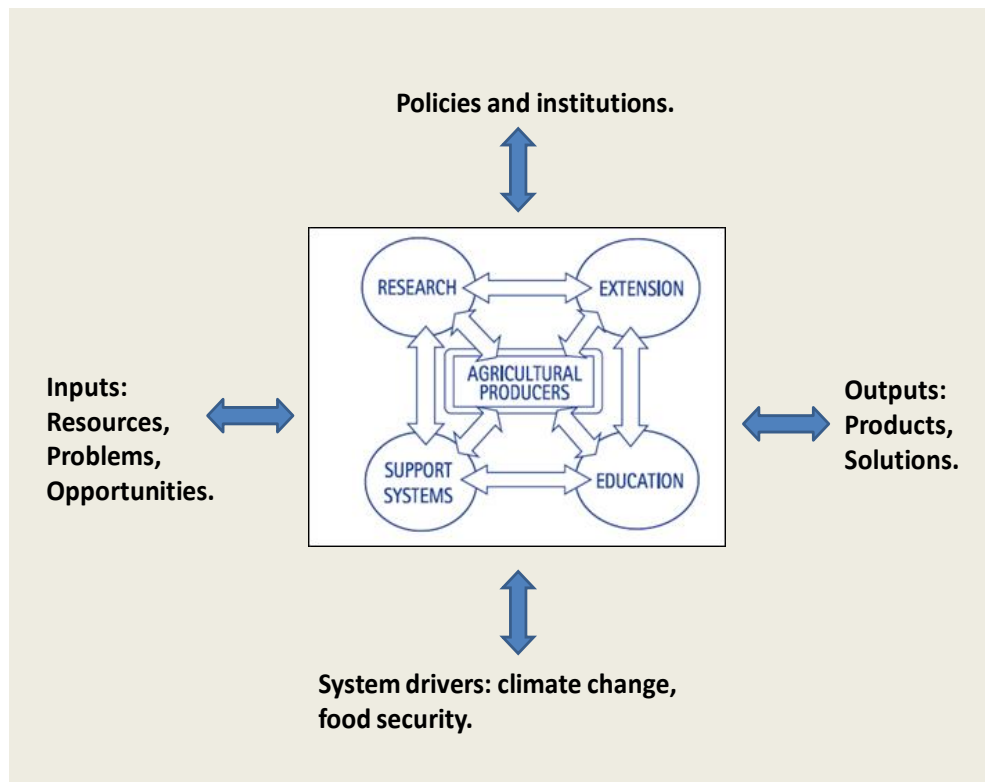


Figure 2.1 - The Agricultural Knowledge and Innovation System “undergoing transformation” (Source: EU SCAR, 2012, p. 26)

Although the system’s purpose is not clear from the title of the diagram, desirable outputs are shown as products or solutions, such as “*resilient and sustainable food systems... ecosystem services, public goods, etc.*” (EU SCAR, 2012, p. 26). The title does identify that the AKIS model is “*in transition*” (EU SCAR, 2012, p. 98) as countries across Europe respond to the changing business and policy environment, although the extent of transition necessary to become fit for purpose, as suggested in the previous section, is not yet clear.

The diagram seems to mix two different attributes of a system: the elements of structure (the system components) and the nature of connections (the relationships between the components). Thus, agricultural producers (structure) and education (relational activity), not educational institutions (structure), are shown to be connected. Although mixing the two might be helpful to our understanding of the relationship, it is not clearly indicated and therefore does not assist in evaluating why the boundary has been placed where it is.

The model also indicates two-way flows between the external environment and the whole system, suggesting the system adapts to the environment while simultaneously affecting it, although it could be interpreted as a 'one size fits all' model. Two-way flows are also shown between some subsystems, and between subsystems and farmers, suggesting an interactive, rather than linear, approach with no apparent hierarchy. However, as we have seen above, farmers' are still regarded by some in the AKIS as receivers of expert knowledge and the accompanying text states that the AKIS organisations *"act upon the knowledge of farmers and rural actors and generate innovations"* (EU SCAR, 2012, p. 26, my emphasis) in response to the external factors shown. The two-way flow with farmers may therefore be aspirational, rather than based in reality. Absent from the diagram are farmers' own learning systems or communities, discussed at sub-section 2.4.5 below. These offer informal opportunities for the exchange of knowledge and practices, what Pelling et al. (2008, p. 870) describe as a *"shadow space for social learning"*, that is a *"space of informal interaction that lies outside of but interacts with formal institutions and relationships"* (p. 869). In this model farmers' knowledge creation and sharing is invisible.

The diagram does not indicate what the two types of arrows signify, for example, what is flowing between the parties, the nature, strength, and quality of the flow, or if it is a cyclical flow. Each type of arrow is shown as the same width; width of arrows in systems diagrams can be used to show relative size of flow, influence, cause, or connection, yet there is no indication here whether the flows are really identical in any regard. Four components that interact with farmers are indicated: agricultural research, extension (advice), support systems, and education. Turning to the subsystems, two approaches to agricultural research are identified in the document, but are not apparent from the diagram: science-driven research and innovation-driven research (EU SCAR, 2012, p. 7). The degree of participation of farmers in the two types of research varies from involvement throughout the process in innovation-driven research, to taking part only in demonstration or dissemination in the science-driven model. Further, the increase in proprietary technologies, such as seeds and precision farming, means that there is increasing plurality in the

research sub-system and, potentially, opportunities for knowledge exchange between farmers and researchers. While this can lead to innovations of greater relevance to the farmer, the *“pervasive colonization of global industrial agriculture by intellectual property controlled by large multinational agrochemical entities”* (Aoki, 2009, p. 2276, referring to seed breeding) means that farmers may be limited in their inventing due to restrictive Intellectual Property rights held by large companies. The active involvement of farmers in agricultural research remains contested and the farmer-inventors’ experience of interactions with AKIS organisations and the patent process is discussed in Chapter 6.

The AKIS does not stand alone, it operates within a larger socio-economic and environmental system *“that determines how individual actors behave and how they interact with other elements of the system”* (Hall et al., 2003, p. 221); that is, all that is outside the AKIS system affects the AKIS system (Lane, 2002, p. 47). The external factors are not shown to inter-relate when this would clearly be beneficial, for example, the overall system drivers of food security and climate change require supportive policy and institutional influences to be achieved. Further, the inputs may be resources, problems, or opportunities, and of natural, human, or industrial origin, implying a host of positions and theories about the best way forward and the risk of conflicting approaches if there is no shared understanding of objectives. It is not clear if the AKIS or its environment incorporates markets, knowledge sources, Non-Governmental Organisations, end users or consumers, or if it recognises the impact of changes in natural conditions, ecosystems, and farming systems (Packham et al., 2007, p. 27). Importantly for this thesis, the wider environment represented in the diagram does not indicate, or possibly consider to be relevant, the social and cultural factors that are so influential on farmers (see sub-section 2.5.1 below). The accompanying text suggests the AKIS is a socio-economic system, made up of socio-technical networks (EU SCAR, 2012, p. 43), although it recognises the need for further research (EU SCAR, 2012, p. 103). There is a multitude of influences on this complex system and the diagram does not include them all.

Apart from the current EU requirement to publicly fund advice to farmers on cross-compliance (known as the Farm Advisory System), the provision of extension services varies across Europe and the level of farmer involvement in the services also varies from funding and managing of services, to little interaction at all (EU SCAR, 2012, p. 64). This is despite an increased focus in the literature on learning processes and the co-creation of knowledge (Faure et al., 2012; Henchion et al., 2009, among others) and relational aspects (Henchion et al., 2009, p. 9), with extension and support subsystems said to favour larger, industrial farmers (EU SCAR, 2012, p. 30). This suggests that in practice the AKIS is driven by economic, rather than development, objectives, which tend to view farmers as rational economic agents even when their behaviour, as seen in the free sharing of user innovations (see sub-section 2.3.3 below), suggests otherwise.

Figure 2.1 also suggests that there are system-wide problems that may hamper productive relationships between the subsystems. First, the subsystems are not always fully connected - the diagram suggests there is no link between research and education, or between extension and support systems. Each subsystem has its own incentives, along with separate incentives to interact with the other subsystems, and these may be misaligned. Incentives may be financial and not reward innovation outcomes (EU SCAR, 2012, p. 70). Second, collaboration and co-operation between different disciplines, within and between subsystems, is often absent. Surveys of researchers and industry figures found that, contrary to industry expectations, researchers *“did not consider the primary responsibility for collaborating with industry and transferring research lay with them”* (Henchion et al., 2009, p. 5). A further difficulty is that researchers often believe the technology should *“sell itself”* (Rogers, 2002, p. 325). This also means that the role of extension advisers, teachers, and innovation brokers in relating new knowledge to practice, and vice versa, is poorly understood.

Thirdly, there are a lack of common goals and values. Henchion et al. (2009, p. 5) found that *“researchers believed their primary mission was to generate high quality science while industry believed they should be equally committed to application of results”*. In this way, collaborative learning is not well supported. Further, weak connections between the education subsystem and

research, extension, and business mean that curricula and research projects do not address emerging issues (EU SCAR, 2012, p. 32), such as the greater emphasis on entrepreneurship and diversification in farming (O’Gorman et al., 2012, p. 2).

Fourth, the boundaries of the AKIS are tightly drawn so that it cannot easily accommodate new entrants without, potentially, changes to hierarchies and dependencies. For example, the plurality of providers following privatisation of extension services means that new providers will take some time to build coherent relationships within the AKIS, one of the reasons suggested above that the current model is not fit for purpose. This clearly has implications for the integration of farmers’ user innovation networks. The disconnections described above may well reflect the fragmented nature of agriculture, the difficulty in understanding the interdependencies in a complex system, and the time needed to create interconnectedness. (EU SCAR, 2012, pp. 69-77). It also suggests the need for institutional innovation in order to bring about increased participation of farmers (Clark et al., 2013, p. 11).

2.2.3 The Irish Agricultural Knowledge and Innovation System

Turning to the AKIS in Ireland, Prager and Thomson (2014, p. 7), in a report for the EU PRO AKIS project on advisory services for farmers, present an “*overview*” of four groupings of organisations (public sector; private sector; farming based organisations and Non-Governmental Organisations; research and education), plus the agricultural media, that interact with “*knowledge users*”, i.e. food producers and processors. The original diagram named some of the organisations and the diagram below (Figure 2.2) shows only the top level of data from the original, yet the diagram provides no information at all about the nature of the relationships between the organisations, and between the organisations and knowledge users, which I assume includes farmers. However, the PRO AKIS report proved helpful in identifying organisations that might provide participants for the key informant interviews, see section 3.5.1.2 below.

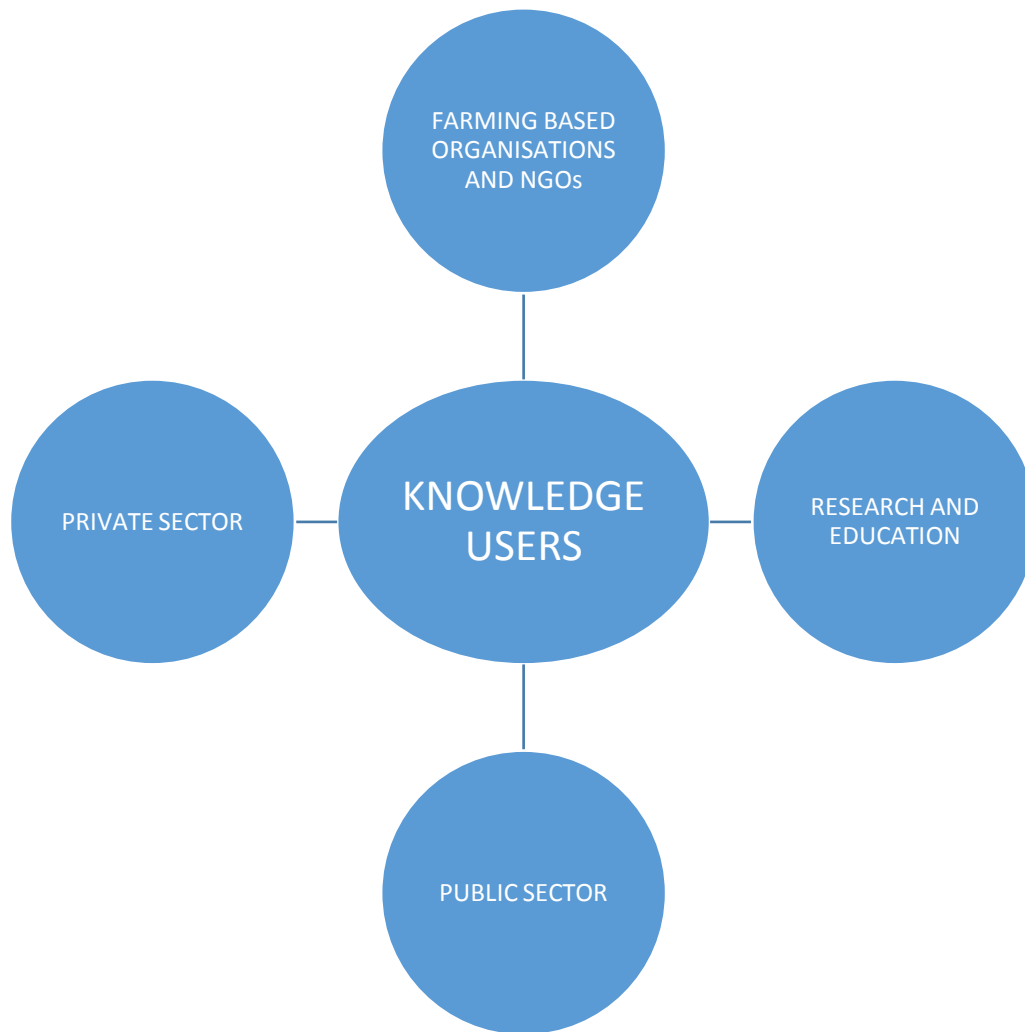


Figure 2.2 Overview of AKIS actors, Republic of Ireland (Prager & Thomson, 2014, p. 7, edited)

A possible reason why this diagram is not very informative is that stakeholder relations within the Irish AKIS are based on sectoral interests and strategic partnerships are actively pursued, yet the *“links and coordination between the main players of the system are not always transparent”* (EU SCAR, 2012, p. 30). Further, substantial elements of the Irish AKIS are found within a single organisation, Teagasc. Unique in Europe, Teagasc is the semi-state body responsible for agricultural research, education, and extension. The PRO AKIS (Prager and Thomson, 2014, p. 24) report concludes these three roles give the Irish AKIS a *“coherent core that is lacking in other countries... where roles are dispersed over a wider range of actors”*, yet the wider system, with its increasing plurality, would benefit from *“improvement in terms of knowledge and information flows to further enhance innovation in Irish agriculture”*.

The PRO AKIS report also acknowledges progress made in farmers' involvement in knowledge sharing through farmer-run demonstration farms and discussion groups (Prager and Thomson, 2014, p. 24) and Teagasc recognises the plurality of knowledge sources to be *"an opportunity ... to adapt the concept of 'open innovation' to embrace stakeholders, especially farmers, in driving the adoption of technologies"* (Boyle, 2012, p. 5). To complement the Prager and Thomson diagram, an *"impressionistic view of linkages in Irish AKIS"* (Boyle, 2012, p. 4) from a presentation by the Director of Teagasc, uses a network approach based *"almost completely on impressionistic evidence and personal observation and reflection"* (Boyle, 2012, p. 3). The diagram (reproduced at Figure 2.3) shows only those actors involved in research, education, and advice, as well as a homogenous stakeholder group, which is assumed to include farmers, so it cannot be said to be a complete representation of the AKIS, unless there are no links between these groups and others shown in Prager and Thomson's diagram. However, it is of interest to this thesis in that it shows, from Teagasc's perspective, farmers' ties with the AKIS, which are assumed in the accompanying text to be two-way and equally solid. Strongest are those with Teagasc advisers, followed by Teagasc education and private sector advisers at medium strength, then equally weak are farmers' ties with Teagasc research, and private sector research and education providers. Boyle (2012, p. 5-6) recognises that a willingness to improve the links *"cannot be taken for granted"* in other AKIS actors and that institutional innovation may be required, possibly using nudge measures, although none are suggested.

Teagasc's mission is *"to support science-based innovation in the agri-food sector and wider bioeconomy so as to underpin profitability, competitiveness and sustainability"* (Teagasc, 2017, p. 4). Looking ahead, Teagasc's Technology Foresight report (2016) sets out significant developments in the fields of digital and genetic knowledge (p. 1), including the potential of open source software and 3-D printing (see sub-section 2.3.3 below), particularly for small farm technology (p. 44). It recommends improved communication with farmers on the implementation of new technologies, in light of the increase in *"user-led innovation"* (p.73), although the focus for future research remains technology acceptance (p. 7), rather than

facilitating farmers' own knowledge creation. The emphasis on digital technologies would seem to be at odds with the prevalence of mechanical and artefactual innovation seen at the farm level.

Similarly, the emphasis at the policy level in Ireland remains on the transfer of expert knowledge, from a range of providers, to farmers and their families through education, advice, and the adoption of new technology and environmental practices to achieve sustainable intensification and increased profitability (Department of Agriculture, Food and the Marine, 2015, p. 45-46). This suggests that, in the Irish AKIS, participatory principles are not fully accepted or embedded, which means that the horizontal and vertical network approaches envisaged for the future AKIS will be difficult to realise. In the case of the EIP the picture is slightly different as funding for the Operational Groups comes from Ireland's Rural Development Programme. The programme is part of the Common Agricultural Policy and aims to enhance its objective of a more competitive and sustainable agri-food sector with more balanced development of rural areas. It presents the Operational Groups as a means to *"foster the submission of innovative concepts and ideas from farmers"* (Department of the Environment, Community and Local Government, 2015, p. 31), a more open approach than that of the science-driven Food Wise Agri-food Strategy outlined in Chapter 1. This suggests that government departments and policies are not as integrated as they might be. The findings of this research study relating to farmer-inventors' suggestions for improvements to AKIS structures and functions are discussed in Chapter 8.

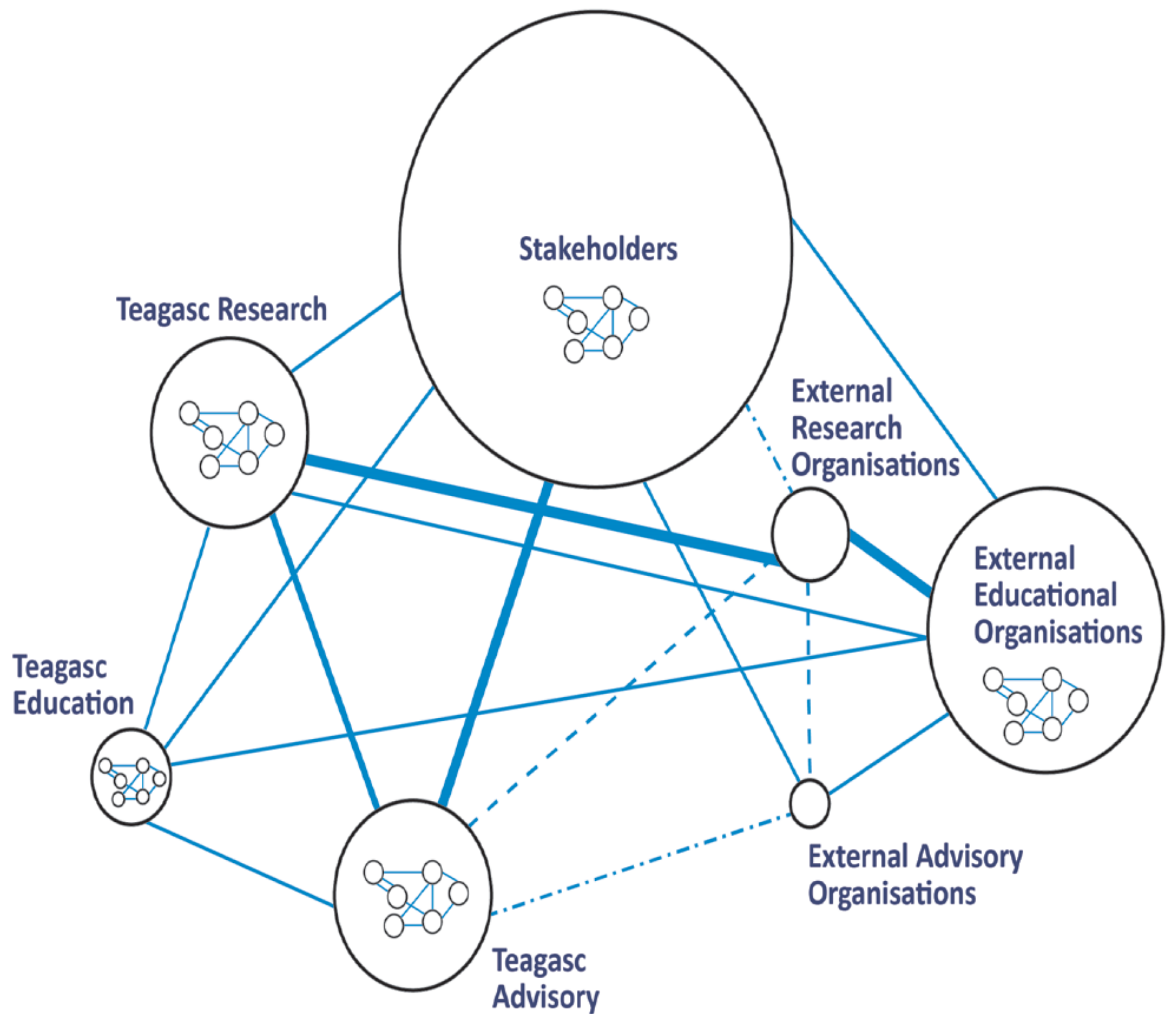


Figure 2.3 - Impressionistic view of linkages in the Irish AKIS (Source: Boyle, 2012, p. 4)

2.2.4 Farmers in the Agricultural Knowledge and Innovation System

The clear message from the AKIS model under review and the network analysis in Figure 2.3 is that farmers are the subjects of the system's attention rather than full participants in their own right. Key relationships within the farming and broader rural communities, such as user innovation networks (von Hippel, 2007, p. 294) and networks of practice (Oreszczyn et al., 2010, p. 411) are omitted or unrecognised. The AKIS is essentially a system of socio-technical relationships involving actors with different types of knowledge (and the associated status), and the model's neglect of farmer networks embeds *"asymmetries (in power, resources, and capacity) ... [that] may exclude some actors or benefit them unequally"* (Rajalahti et al., 2008, p.

xi). Further, innovation processes that might benefit the most vulnerable might be “*neglected or undermined*” (Berdegué 2005 in Rajalahti et al., 2008, p. 32) in favour of better economic prospects. This reinforces Vanclay’s (2004, p. 222) view that greater attention be paid to the social and cultural aspects of farming and sustainability. To bring the AKIS, as depicted, to greater balance would involve recognition of user networks and communities of practice, and a broadening of those involved in knowledge production, use and dissemination (Gaventa and Cornwall, 2001, p. 70), as well as attention to the permeability of the AKIS boundaries to knowledge flows, particularly from user innovation networks or communities of practice.

When considering knowledge flows at the boundaries between farmers’ communities of practice and the AKIS then additional connecting mechanisms come into play to accommodate the difference in competencies and experience between the groups (Wenger, 2000, p. 233). Agents act as knowledge brokers between communities by contextualising and translating practice in both directions, making connections, moving knowledge, and importing new ideas (Oreszczyn et al., 2010, p. 414). Farmers work with trusted individuals (for example, family members, agronomists, certain research contacts) who provide credible connections

“between farmers’ network of practice and the wider community ... [by] ... negotiating meaning across boundaries ... [through] ... participative connections that involve processes of translation, coordination, addressing conflicts, mobilising attention, and negotiating alignment between perspectives” (Oreszczyn et al., 2010, p. 414).

Mapping of knowledge flows in agri-environmental settings have shown that knowledge generally flows in one direction, from researchers to farmers, and with little knowledge exchange between intermediaries (Oreszczyn and Lane, 2012, p. 205). A lack of brokerage means that farmers must seek out knowledge for themselves, which may be burdensome and ineffective (Oreszczyn et al., 2010, p. 415).

2.2.5 The Agricultural Knowledge and Innovation System: Mirror or Roadmap?

Overall, the AKIS is a useful approach to the conceptualisation and analysis of institutional structures and functions, as well as the relationships and knowledge flows between actors in agriculture, particularly as pluralisation increases, yet the explication and diagrams are not always helpful. The AKIS models presented do not show a joined-up external environment: important drivers, key linkages, and actors are missing; farmers are not identified as participants in their own right. The AKIS aspires to positive outcomes for identified problems and opportunities that require innovative solutions, yet the evidence above suggests it is an economically driven model that hides as much as it reveals. There is little evidence from this review of the model to suggest that linear approaches, although contested, are declining significantly in the increasingly pluralist AKIS and it is not clear how the future AKIS will be shaped. In Chapter 6 I present the data relating to the farmer-inventors' perspective of their interactions with the formal organisations of the AKIS.

2.3 User Innovation

2.3.1 Broad Understandings of Innovation

Before we look at user innovation in detail it is worth considering how innovation has been characterised in the literature. This is generally in terms of a process or the output of the process, which may be technological or institutional, and includes artefacts, products, services, processes, or practices. Von Hippel (2007, p. 302), from the management perspective, describes innovation as *“an economically motivated activity”*, although not all innovations are intended for the market, for example those that improve a firm's internal management processes or most user innovations. A recently theorised form, 'social innovation' refers to innovations that improve a product, practice, process, or service while meeting a social need, thereby potentially effecting social change, in a socially responsible way, usually through non-profit organisations (EU SCAR, 2012, p. 48; Murray et al., 2010, p. 3; Mulgan, 2006, p. 146). In rural areas, the relational aspect of social innovation is suggested to offer solutions to problems of fragmented rural development

that are innovative yet, because they originate in endogenous collective and collaborative action, maintain stability (Neumeier, 2012, p. 54). Bock (2015, p. 10-12) offers examples of rural social innovation, such as multifunctional local shops and co-operatives for broadband connectivity. This study focuses on the invention of agricultural artefacts by farmers, i.e. both their approach to the invention process and the outputs themselves. Yet, innovation does not occur in a vacuum, the institutional context, i.e. laws, standards, social and cultural norms, influences approaches taken to the innovation process, as discussed next.

2.3.2 Modes of Innovation

The traditional understanding of innovation is a vertically integrated linear process, contained and controlled within firms, that moves in phases from basic scientific discoveries to research and development, through marketing, production, and distribution to the customer (Bogers and West, 2012, p. 65). Known as the *“technology push”* model, which is driven by scientific and technology advances, it contrasts with the *“demand pull”* model, wherein market needs determine the development of innovations (Nemet, 2009, p. 701). The advent of communication technologies has, over the last thirty years, seen the development of distributed models of innovation, whereby knowledge and innovation is created outside the firm. These include social innovation, as described above, and open innovation which involves firms *“co-operating across firm boundaries”* and with users to develop innovations (Bogers and West, 2012, p. 61; see also Chesbrough et al., 2006). User innovations arise outside firms and are *“freely shared within and beyond the user network”* (von Hippel, 2007, p. 294), although some are commercialised.

In Table 2.1, I contrast these four innovation models in some key aspects. It shows that the purpose and mode of innovation has evolved beyond the profit-driven vertical and open models, to the more collaborative user and social models that operate in networks outside formal research and development structures to achieve economic and non-economic benefits for a wider range of people.

Innovation modes and attributes				
Attribute	Vertical integration	Open innovation	User innovation	Social innovation
Objective	Control of the end-to-end innovation process	Maximisation of innovation effectiveness	Support users to be innovators	Society, environment benefits
Stakeholder	Firm	Firm, other firms in value chain	Users, producers	Multiple
Level of analysis	Firm	Firm	Innovation	System
Key success measures	Profit	Profit	Quantity of (significant) innovations, utility	Relevance, sustainability, social acceptability
Locus of innovation	Within firm	Outside firm	Within users	Across networks
Type of innovator	Organisation	Organisation	Individual	Group or individual
Innovation mode	Linear, internally controlled	Non-linear, best of breed	Non-linear, cumulative	Non-linear, social learning
Norms	Managerial hierarchy	Market exchange	Co-operation	Collaboration
Relationship with other innovators	None	Exchange	Co-operate	Co-design
Knowledge spill-overs	Blocked	Paid	Free	Free

Table 2.1: Contrasting Modes of Innovation (Source: Bogers and West, 2012; additional material from EU SCAR, 2012; Mulgan, 2006)

2.3.3 Innovation as a Design Process

2.3.3.1 The Double Diamond process

Across the academic disciplines there are many ways to describe the progress of an idea from conception to market ready product. Given the interest here in farmers' approaches to invention, the knowledge involved, and the artefactual outputs, I introduce an engineering model from the design literature that describes the process of product development as one of knowledge accumulation and synthesis. The Double Diamond model (UK Design Council, 2006,

p. 6), developed following qualitative research on the design processes of leading companies, represents thinking and knowledge as diverging and converging during the different phases of the design process in firms. It differs from the traditional linear model (Howard et al., 2008, p. 162) in that each of the phases consists of a series of iterative loops involving exploration and testing of ideas (UK Design Council, 2007, p. 10). Below I link the phases of the Double Diamond model to insights on the changing states of knowledge in the research and development of technology-based innovations. Lane and Flagg (2010) from the knowledge translation perspective, propose an ideal-type scenario involving three states of knowledge of increasing tangibility: discovery, invention, innovation. I also identify how aspects of user innovation might manifest in the different phases.

The Double Diamond model (Figure 2.4) comprises four phases:

- Discover - responding to market or social trends, the project commences with an initial idea or inspiration in a *“phase of divergent thought”* (UK Design Council, 2006, p. 8). Drawing upon a broad range of influences, including user and market research, this phase often results in a design specification (UK Design Council, 2006, p. 10). In the case of user innovation, the inventor’s self-identified needs usually initiate a problem solving process;
- Define - this phase of convergence and synthesis involves what Lane and Flagg refer to as the generation of new knowledge (or a recombination of existing knowledges) that defines the problem by filling the recognised gap or need. Described as novel, because *“it is the first articulation of something not previously known or demonstrated”* (Lane and Flagg, 2010, p. 3), the nature and level of verification will depend on the arena of discovery, but will generally include some form of replication and peer review. In a user innovation process this might include collaborative peer evaluation or replication. This phase also involves interpretation and alignment of market needs to business objectives

and, in making the business case, some ideas are rejected (UK Design Council, 2006, p. 10);

- Develop – in the third quarter ideas approved for resource allocation are subject to divergent design-led iterations that bring the project to fruition. The move from breakthrough to tangible invention introduces issues of feasibility with successful development testing resulting in a proof-of-concept prototype (Lane and Flagg, 2010, p. 3). The involvement of internal (e.g. design, manufacturing, marketing) and external stakeholders (sometimes including users) are important to refining the idea (UK Design Council, 2006, p. 19). In a user innovation process this might include collaborative peer improvement. At this stage the protection of the intellectual property may occur (Lane and Flagg, 2010, p. 4);
- Deliver - before the innovation reaches the state where it can be mass-produced and marketed, there will be further adjustments and modifications to achieve *“utility, in addition to the novelty and feasibility of the prior knowledge states”* (Lane and Flagg, 2010, p. 4), thereby resolving the problem identified at the Discover phase. Once launched into the market, firms will generally use formal and informal feedback loops to collect information on business objectives and user satisfaction relating to the product. In a user innovation process the delivery phase would involve peer to peer diffusion through user innovation networks, with other users providing feedback or making their own adaptations and improvements to the product.

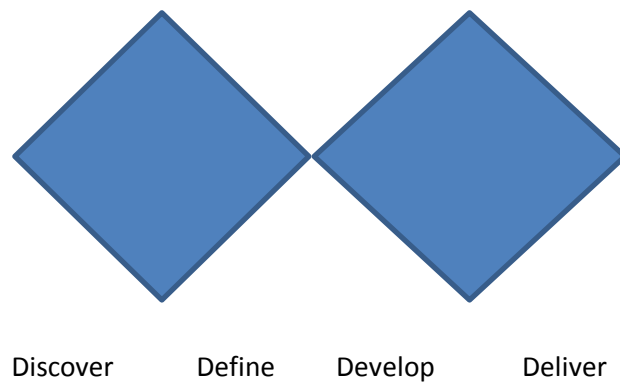


Figure 2.4: the Double Diamond Framework (Source: UK Design Council, 2006, p. 6)

The model depicts an iterative approach in firms in which the coming together of knowledge as novelty, feasibility, and utility is *“enabled by the knowledge of the participants – not only of science, technology and development processes, but also the knowledge of basic or applied problems in search of a solution”* (Bogers and West, 2012, p. 65). The user innovation process, by comparison, occurs outside the firm and may not involve all the formal processes described above, yet the design phases, divergent and convergent thinking, knowledge states, and broader stakeholder participation may well be similar (see chapter 6, sub-section 6.4).

2.3.3.2 Novelty and the Effect of the Design

Turning to the effect of the design output, the literature offers a range of perspectives on how to measure or assess novelty, which is important to the firm in terms of potential Intellectual Property and the likelihood of market success of an innovation. The Double Diamond model describes the design process and identifies the Define phase as the locus of generation of novel solutions resulting from new knowledge or combinations of existing knowledges. Norman and Verganti (2014, p. 82), in the design literature, consider two effects relating to the novelty of an innovation: incremental (*“improvements within a given frame of solutions”*) and radical (*“a change of frame”*). Incremental innovation refers to small changes that help improve performance and lower costs in a continuous cycle, while radical innovation (after Schumpeter, 1943) is often characterised as disruptive, implying a discontinuity with the past, often through

the introduction of new technologies. This simplistic binary is used in much of the design and innovation literature, despite radical innovation being relatively rare: *“successful radical innovation occurs infrequently in any particular area - perhaps once every five to ten years”* (Norman and Verganti, 2014, p. 83).

Henderson and Clark (1990, p. 2), in the organisational studies literature, find the

“distinction between radical and incremental innovation ... is fundamentally incomplete. There is growing evidence that there are numerous technical innovations that involve apparently modest changes to the existing technology but that have quite dramatic competitive consequences”.

There are studies in the design and innovation literature that propose intermediate gradations of novelty between radical and incremental (see Howard et al., 2008, for an overview of design classifications). Pahl et al. (2007, p. 64), for example, offer three classes of design:

- Original design: using new combinations of known solution principles, either based on the latest scientific knowledge or new combinations of existing solutions;
- Adaptive design: the embodiment of a known solution principle is adapted to new requirements and constraints;
- Variant design: the sizes and arrangements of parts and assemblies are varied within the limits set by previously designed product structures.

Offering another perspective, Strumsky and Lobo (2015, p. 1449), in the innovation literature, use nearly 200 years of US patent data, in particular the classification codes for technological capability, to create a taxonomy that identifies through the codes (and their combinations) four sources of technological novelty in patented inventions:

- Origination: all the codes are new (meaning they have not been used before in the patent record), i.e. the invention has no antecedents;

- Novel combination: the codes consists of new combinations with at least one new code;
- Combination: the code consists of new combinations of technological capabilities used in previous patents;
- Refinement: all of the codes and code combinations have been used previously.

By relating novelty to distance from the existing paradigm of patented inventions, they find that less than 1 per cent were originations or novel combinations, with combinations at 42 per cent and refinements at 56 per cent. This supports the view that radical innovations are indeed rare, with re-combinations and modifications of existing technologies the dominant source of patentable inventions. This is recognised by Henderson and Clark (1990, p. 3) in their definition of intermediate ‘architectural innovation’ as the *“reconfiguration of an established system to link together existing components in a new way”*. Similarly, ‘configurational’ innovation, from the Information and Communication Technology (ICT) literature, dynamically reframes familiar elements to produce something new as *“different trajectories of technological change are interwoven and evolve simultaneously”* (Peine, 2011, p. 505). There is no single agreed definition of novelty and it is clear that the radical-incremental binary does not represent the significant number of inventions which result from the combination or adaptation of existing knowledges and technologies to new problems and purposes.

When it comes to the novelty of products developed by firms that engage users in the design process, the literature suggests that the resulting innovations tend to be at the incremental end of the spectrum (Menguc et al., 2014, p. 325), however there is potential for more disruptive innovation when cutting edge users are involved (Lilien et al., 2002, p. 28; see below). This thesis focuses on innovations conceived, designed and produced outside firms by users, their approach to the innovation process and the novelty of their inventions are discussed below.

2.3.4 Characteristics of User Innovation

2.3.4.1 Innovation By and For Users

The remainder of this section will focus on user innovation, whereby *“users create and modify products and services to serve their own needs”* (Flowers et al., 2010, p. 4). The user innovation concept was first theorised in the 1970s by von Hippel (1976), who is the leading authority in this growing school of thought. The literature has expanded very quickly, derived mainly from small scale empirical studies, and it has been criticised for a lack of theorising beyond the *“microeconomic theory of innovation”* (Bogers et al., 2010, p. 865). A more coherent framework might view user innovation from the perspective of *“learning and information processing; resource-, capability-, or knowledge-based views of the firm; and evolutionary economic theory, or some combination thereof”* (Bogers et al., 2010, p. 866). This study takes a different approach by applying sociological theory to consider not only economic but also social and cultural influences on user innovation.

User innovation differs from other modes of innovation that involve users. It is innovation by users, known as user-innovators (von Hippel, 1977) whereas the open mode, discussed above, represents innovation with users (as proposed in the European Innovation Partnerships), while innovation for users, as seen in the user-led mode in Finnish firms (Ministry of Employment and the Economy, 2015, p. 28), involves users in design concepts and execution.

User innovations often result from an unmet need and the user-innovator’s *“direct and repeated personal experience with a problem”* (Lüthje et al., 2005, p. 959) for which *“there is no appropriate market supply”* (de Jong and von Hippel, 2008, p. 12). A synthesis of user surveys reports that ten to forty per cent of respondents report developing a new product for personal or in-house use (von Hippel, 2007, p. 300). User-innovators may be individuals (outside or inside firms) or firms and the focus of this thesis is user-innovators in agriculture, albeit those in the public domain, who are referred to as farmer-inventors.

The incentives that might stimulate a user to innovate will vary and have been described in the literature, mainly from an economic perspective, as direct, private, social, and economic. The primary benefit is the use of the product to meet the user's self-identified need. Mountain bike user-innovators, for example, reported high direct benefit from using their own innovations that improved the braking system (Lüthje et al., 2005, p. 954). Private incentives might include network effects (distribution of the innovation and the stimulation of improvements and related innovations) and increased reputation with peers and (potential) employers (von Hippel, 2007, p. 306), to the extent that *"innovative users sometimes receive significant support from the peer community in the new product development process"* (Hienerth et al., 2014, p. 852). Surveys of users involved in open innovation find that social incentives such as *"communal norms... altruism... generalised reciprocity"* are established through sharing between users, who also experience *"enjoyment and learning"* (von Hippel, 2007, p. 307). Economic incentives include the returns to innovators by way of control of innovation knowledge through patents, trade secrets, and the prevention of *"non-compensated spill-overs"* (von Hippel, 2007, p. 304).

2.3.4.2 The User Innovation Process

The output of the user innovation process may be physical or information-based (for example software) and has been studied in a range of sectors, including computers, software, baby goods, chemical processing, building hardware, lifestyle sports, food, and scientific instruments (Shah and Tripsas, 2007, p. 125), but not agriculture. Notwithstanding the studies to date, a representative survey of Dutch small and medium enterprises demonstrates that user innovation occurs in almost all industries (de Jong and von Hippel, 2008, p. 29) and in some industries, for example scientific instruments, users create the majority of significant innovations (von Hippel, 1976, p. 220).

In terms of design effects, as discussed above, there is no single approach to the novelty of user innovations and, similar to innovation in firms, user innovations are often categorised as either radical or incremental. Arising to meet the needs of the user, a number of studies suggest that

“user innovations are more likely to be breakthrough innovations with disruptive effects ... that are functionally novel, as they are most aware of where and how current techniques, equipment or software fail to meet their needs” (de Jong and von Hippel, 2008, p. 9). In the same way, Shah and Tripsas (2007, p. 128) find user innovation can result in *“radically new technology and in some cases the creation of entirely new industries”*, such as rodeo kayaking.

At the other end of the novelty spectrum, Lüthje et al. (2005, p. 957) find that mountain biking innovations are predominantly *“minor novelties with technological progress mainly consisting of accumulated improvements and minor modifications to the same basic design”*. However, they also describe a safety innovation that combines existing components in a new way such that it might be considered an architectural innovation (Henderson and Clark, 1990, p. 3, above): *“knee-activated brake levers that ... provide greater braking power than handbrakes ... By creating a way to activate his brakes using his knees”* (Lüthje et al., 2005, p. 961). User innovations can therefore be placed on a spectrum of novelty that includes radical, architectural and incremental innovations.

Using another approach, arguably analogous to the concept of novelty, Riggs and von Hippel's (1994) study of user innovation in scientific instruments uses expert opinion (i.e. users and manufacturers) to consider whether an innovation was scientifically or commercially important. Those innovations relating to the *“enabling or achievement of scientific advance”* (p. 464) were generally developed by users and offered new functional capability, i.e. *“something that could not be done previously”* (p. 465), or improved instrument performance, i.e. sensitivity, resolution, or accuracy. Innovations with high commercial importance or *“impact on manufacturers' sales”* (p. 465) tended to be developed by manufacturers and offered increased convenience or reliability, e.g. ease of operation, or improved instrument performance.

We considered above the problem-solving process in firms using the Double Diamond model. The literature is largely silent on the detail of the user-innovator's design approach, yet von Hippel (2005, p. 65) differentiates between such processes in firms and innovation by users, in

that users' trial and error approaches tend to involve a full prototype of the intended product in its real world environment, whereas a firm might test only a portion of the new product in a limited range of conditions. He explains trial and error as a *"learning process"* (p. 63), wherein *"the error is the new information or learning... that the experimenter did not predict"* (p. 63), resulting in changes to the prototype, which is then re-trialled, as seen in the iterative loops of the Double Diamond model.

Further understandings of trial and error approaches are offered by the entrepreneurship literature which describes the process of innovation in resource constrained conditions as a type of *"bricolage"* (after Lévi-Strauss, 1966, p. 16). In this scenario user-innovators combine and/or recombine existing resources at hand (e.g. knowledge, materials, technologies) in unconventional ways to a new purpose, to respond to contingencies, or pursue an opportunity. Baker and Nelson (2005, p. 362), in an exploratory constructivist study, associate bricolage with the testing of contextual limitations by actors in order to create value as it *"called forth hidden and seemingly unrelated resources that would otherwise not have been put to any productive application"*, often through a process of trial and error. Louridas (1999, p. 4) compares the traditional engineering and bricolage approaches and finds that the bricoleur has a closed set of materials, tools, and knowledge to work with, while the engineer has access to wider knowledge and material resources: *"the engineer and the scientist break down, decompose and analyse; the bricoleur reorganises"*.

Garud and Karnøe (2003, p. 278) use the term to represent *"resourcefulness and improvisation on the part of involved actors"*, claiming that agency in the bricolage process is both embedded and distributed among a number of individuals who contribute their knowledge and skills to the evolving innovation. In this way, bricolage *"preserves emergent properties"* (Garud and Karnøe, 2003, p. 296) and makes use of local, as well as expert, knowledge in *"co-shaping"* (Garud and Karnøe, 2003, p. 296) the innovation. Louridas (1999, p. 4) points out that the emergent nature of the process also means that, in contrast to the controlled process in firms, the *"final result of the bricoleur's efforts is never an ideal fit to the requirements of the project ... The result is unique"*

and unpredictable". In this section I have brought together understandings of design processes and the novelty spectrum in relation to user innovation, it is suggested that processes of continuous improvement may lead to incremental innovations, with architectural innovations emerging from bricolage, while, on occasion, reframing a problem can lead to radical innovation.

2.3.4.3 User-innovators' Knowledge and Capabilities

As we have seen above, the trial and error innovation process involves knowledge accumulation and synthesis and a key resource, therefore, is the knowledge, skills, and experience of the user-innovator. Lüthje et al. (2005, p. 961) find that mountain biking user-innovators exhibited *"significantly higher general technical knowledge"* than those who did not take an idea to the prototype stage. This knowledge was found to be pre-existing, generally from work or hobbies outside biking, with a small number acquiring new knowledge to develop their innovation, often from friends (Lüthje et al., 2005, p. 962). Further, von Hippel et al. (2011, p. 28) found user-innovators surveyed are more likely to be *"highly educated (with bachelor's, master's or Ph.D. degrees), to have a technical education (in science or engineering or as a technical professional) and to be male"*, although their study did not target agriculture.

In the case of radical innovations, defined as *"new products or services with a high degree of innovativeness"* Lettl et al. (2006, p. 252), in the field of medical equipment, found that users (usually surgeons) were particularly advanced in the technological domain *"because of their specialized knowledge and experience"* (p. 264). Further, they found that users who contributed substantially to the development of radical innovations were *"open to new technologies ... embedded in a supportive environment [with] strong intrinsic motivation"* (p. 264).

There is also a subset of user-innovators (Shah and Tripsas, 2016, p. 287) who are deemed to be *"lead users"* (von Hippel, 2007, p. 300). Lead users are the users most likely to innovate in any particular domain (von Hippel, 2007, p. 300) and their two attributes: *"a high personal need for innovations... and ... [being] ahead of an important trend"* (Franke et al., 2006, p. 304) mean their leading edge innovations are of particular interest to commercial interests seeking to exploit

their value. Lead users are the focus of a strand of research which has developed around how firms might adapt their market research and product development methods to identify lead users whose innovations would make commercially attractive products and, further, to involve them in new product development (Lüthje and Herstatt, 2004, p. 565). Such processes have been found to generate products of greater novelty and market share than, and similar levels of Intellectual Property protection to, products conventionally conceived in-house (Lilien et al., 2002, p. 28).

However, the lead user approach is not without its risks: the user may feel unfairly treated in terms of Intellectual Property rights and the manufacturer may not find appropriate innovations or lead users (Hienerth et al., 2014, p. 850). In the agricultural domain, Sumberg et al. (2013, p. 240) acknowledge that while farmer involvement does occur in public sector research in less developed countries, where it exists the feedback loops do not always work as well as they might. They suggest that the systematic involvement of users in agricultural research has the potential to increase the relevance of new products. Lead user processes from the firm's perspective are not the focus of this thesis, although some farmer-inventors might be lead users, being highly motivated to develop novel products to meet their needs. Next, we consider how user-innovators share and commercialise products originally developed for their own use.

2.3.4.4 Diffusion of User Innovations

User innovation encompasses innovations for personal or in-house use, as well as those that are freely shared or exploited for profit (von Hippel, 2017, p. 144). In contrast to the linear processes of the vertically integrated model of innovation, de Jong (2016, p. 79) proposes three options for the diffusion of user innovations:

- free sharing, whereby other users may inspect, copy, or adopt the innovation without charge;
- user commercialisation, through the setting up of a new enterprise to market the innovation; or

- the innovation is taken up by a firm that produces it for the market.

In addition to the user's direct, private, social, and economic incentives for innovating, the incentives for the diffusion options have also been considered in the literature. A review of surveys of user-innovators (de Jong, 2016, p. 80) finds that many do not reveal their innovations at all, possibly because it is of interest only to the innovator or because sharing requires too much effort.

In the case of the first diffusion option, the free sharing of information sufficient to replicate a product at no charge to other users (as well as rivals and free riders) means that the user-innovator has effectively given up their intellectual property (IP) rights. This applies also to those users who are more selective about the extent of their free sharing, preferring to limit it to *"close friends and other strong ties in their networks"* (de Jong and von Hippel, 2008, p. 32). Free sharing suggests that non-economic benefits of the private and social types mentioned above may act as motivating factors for user innovation in such cases. Another factor in the decision to freely reveal an innovation is that user-innovators, as is found to be the case for small businesses, may find the formal process of IP protection to be costly, difficult, and time consuming and, should IP rights be infringed, they lack the resources to seek redress through the courts (Kitching and Blackburn, 1998, p. 331). As a result, some small businesses deploy informal IP protection strategies or norms based approaches over legal measures. These might include informal community based interventions, such as shaming or exclusion, in the case of chef's recipes (Fauchart and von Hippel, 2008, p. 197), or business practices, such as building high trust relationships with key contacts or operating in a market niche with specialist knowledge requirements (Kitching and Blackburn, 1998, p. 332).

In relation to the second diffusion option, user commercialisation or *"user entrepreneurship"* (Shah and Tripsas, 2007, p. 126), economic incentives arise for the entrepreneurial user-innovator from future sales of the product or its design to the market, other users, or manufacturers, or by keeping information about the product secret from competitors (Shah and

Tripsas, 2007, p. 129). The main economic advantage that the user entrepreneur has over a commercial manufacturer is that the information about user needs and context, necessary to develop the product, is freely available to the user but may be expensive to collect for the manufacturer, depending on “stickiness” (von Hippel, 2007, p. 300). The greater the stickiness, the higher the cost. Sticky information is found at user locations and is often gathered more economically by users themselves as it may be tacit or expressed in vernacular terms. In this way the “locus of innovation” (von Hippel, 2007, p. 297) may be dependent on the stickiness of information. This would seem to accord with the reductionist view that there is little knowledge, beyond the knowledge embodied in artefacts or the truly inarticulable, which cannot be codified if benefits and costs are justified (Cowan et al., 2000, p. 241). Notwithstanding the advantage to user entrepreneurs of sticky information, some user-innovators face difficulties in changing role from innovator to manufacturer as different skills and resources are required (Henkel et al., 2016, p. 379). For this reason some user-innovators pass their innovations to an established manufacturer for market development.

In the third diffusion option, the user innovation is taken up by a firm that produces it for the market because sufficient demand is identified or it is an innovation of volume or one that requires investment (von Hippel, 2007, p. 308). The user-innovator provides their innovation to the firm with or without compensation (such as royalties paid under a licence agreement or a fee) (de Jong et al, 2015, p. 1857). The user-innovator’s engagement with the firm may be initiated by the user-innovator or the result of a lead user process.

2.3.4.5 User Innovation Networks

In the previous subsections users were presented as innovating independently of manufacturers with different options for the diffusion of their inventions. In this subsection users’ networks are used for the “development, production, distribution and consumption” (von Hippel, 2007, p. 295) of their inventions, with design information and improvements shared within the network. A user innovation network is described as “nodes interconnected by information transfer links

which may involve face-to-face, electronic or any other form of communication. User networks can exist within the boundaries of a membership group but need not” (von Hippel, 2007, p. 294).

The horizontal qualities of the user innovation network are ascribed to its being composed of users, although sometimes non-users (e.g. suppliers) may be included. Von Hippel (2007, p. 295) identifies three conditions for healthy user innovation networks:

- *“at least some users have sufficient incentive to innovate;*
- *at least some users have an incentive to voluntarily reveal information sufficient to enable others to reproduce their innovations;*
- *user self-production can compete with commercial production and distribution”.*

The development and free sharing aspects (the first two conditions listed) of user innovation networks are always present and the incentives for the free sharing of product information are discussed above.

The third condition for a user innovation network, the carrying out of the production and distribution functions by users (the user commercialisation diffusion option), depends on the nature of the innovation, the scale of production, and any required investment. Information products are cheap and easy to share via the Internet or user network mechanisms; information about physical products can be similarly distributed. User manufacture of physical products generally involves low volumes of production and no or low *“model-specific”* investment (von Hippel, 2007, p. 309). The sticky nature of the knowledge of user needs grants user-innovators a cost advantage over manufacturers, while user-innovators are unlikely to have the resources to import sticky information from outside sources (Lüthje et al., 2005, p. 963).

User commercialisation follows a different path to that of the traditional model in that it is an emergent process, embedded in the user community, with community members providing support, feedback and, through their experience of adopting the innovation, indications of the market potential of the product (Shah and Tripsas, 2016, p. 293). In this way user innovation

networks can be said to function, not just as conduits for information between users, but like communities of practice (Wenger, 1998, p. 72), being *“collective social processes, fed by trial-and-error problem solving, learning by doing, and the recombination of knowledge from multiple individuals with heterogeneous experiences”* (Shah and Tripsas, 2007, p. 135). The findings of this research project relating to the farmer-inventors’ attitudes towards free sharing and commercialisation of their inventions, including Intellectual Property, are discussed in Chapters 5 and 6.

User innovations are generally based on local needs, knowledge and skills (Bogers and West, 2012, p. 68) and advances in technology mean that, most recently, user-focused spaces such as the Maker Movement (Anderson, 2012, p. 21), hackathons (defined as a *“collaborative coding spree”*, Cardona and Tomancak, 2012, p. 664), and hackerspaces (see the Farm Hack website, for example) are further challenging established manufacturing practice through the use of open source software and hardware (using 3-D printers, for example) in public access spaces, such as FabLabs (fabrication laboratory) (Schön et al., 2014, p. 89) and Living Labs (*“user-centric environments for open innovation”*; Schaffers et al., 2007, p. 1). Originally spaces for *“civic hacking and data activism”* (Briscoe and Mulligan., 2014, p. 4), these spaces are increasingly appropriated by corporate interests.

2.3.4.6 Farmers as User-innovators

Although there have been no detailed studies of farmers as user-innovators, 7 per cent of respondents in a survey of Dutch small and medium enterprises were farming related businesses, of which 43 per cent reported some type of user innovation in the last three years (de Jong and von Hippel, 2008, p. 15). The authors reflect that farming is *“generally considered not to be very innovative and in need of improvement, but ... there is more innovation going on ... than policy makers are aware of”* (de Jong and von Hippel, 2008, p. 17). This is not the case only in the Netherlands, it is also evident elsewhere, yet the increasing professionalisation (and attendant status) of agricultural research and development based in settings remote from the farm has

meant that *“incremental farmer-led --improvements are not officially seen as innovation, by contrast to lab-based biotech research”* (Levidow, 2011, p. 11). This view indicates the extent to which the increasing complexity of farming inputs and value adding post-production technologies has seen farmers’ tacit knowledge displaced and, in the case of seed breeding, legally restricted (Braun and Herstatt, 2007, p. 294). The family farm, which has persisted and adapted to industrialised agriculture, is now effectively *“integrated into an agri-industrial complex”* (Morgan and Murdoch, 2000, p. 162), occupying a space between industrial input suppliers and commodity processors.

By way of contrast, there has been a renewed interest in farmers’ research, generally in less developed countries, since the 1980s (Bentley et al., 2010, p. 130) (see also Critchley, 1999; Saad, 2002; Bentley, 2006; Scoones et al., 2008; Wettasinha and Waters-Bayer, 2010). A European Commission (2012, p. 109) discussion paper on rural growth suggests that agricultural research might achieve greater impact if research was brought *“close to the farm”*. While each farmer’s values, goals, and beliefs will affect their attitude to innovation (Gasson, 1973, p. 534), views persist that farmers are passive receptors of information from advisory services (Farrell et al., 2008, p. 8) rather than independent creators of knowledge, able to influence research agendas. Unsurprisingly, this view is contested, *“farmers are experimenters, no matter what happens, even if outsiders do not encourage them to do so”* (Bentley et al., 2010, p. 135).

Bellon (2001, p. 4) suggests that such experiments are *“learning experiences”* may result in farmers *“generating and adapting new technological options that fit their specific needs and conditions”* while Hoffman et al. (2007, p. 356-7) set out five areas of farmers’ experimentation:

- farm equipment, from patented inventions to modifications of tools, this is the most prevalent area;
- crop varieties and animal breeds *“to fit local environmental conditions and meet specific needs”*;
- classification systems or *“folk taxonomies”*;

- production systems and pest management;
- social innovations, *“including socio-cultural and institutional innovations”*.

Bentley (2006, p. 457) cites cases where knowledges are combined to reduce inputs (labour or capital) in response to economic, market, and environmental changes. He finds that understandings of the farm environment mean that farmers will not adopt a technology, even if proven in theory, if it runs counter to their experience and involves increased inputs. Farmers have *“different ways of thinking and different ways of doing things”* (Knickel et al. 2009, p. 138, citing van der Ploeg et al., 2004) which means their inventions, being based in action, are often ignored by agricultural researchers, *“on the grounds that they are merely incremental, non-technological or not appropriate”* (EU SCAR, 2012, p. 30).

Farmers may be inventive, but their experimentation is not regarded as fully scientific. The literature highlights areas of similarity between research methods used by farmers and scientists, yet stops short of declaring them equivalent: *“Folk experiments really are experiments, but they are not science”* (Bentley, 2006, p. 459). He finds that farmers *“form hypotheses unselfconsciously, intuitively”* (p. 454) and use qualitative-type methods that suit their skills, for example, observational experiments with multiple variables and no control group, i.e. *“testing several ideas simultaneously in the same plot”* (p. 456), and monitoring results. Hoffman et al. (2007, p. 361), describe farmers’ methods as *“trial and error strategies”* rather than formal efforts to isolate *“cause and effect relationships”*. Other perceived shortcomings in farmers’ research methods are suggested to include a relaxed approach to research protocols (Bentley, 2006, p. 459), uneven distribution of innovation capacity due to a reliance on local resources, and a focus on immediate rather than longer-term issues, such as environmental changes or building resilience (Hoffman et al., 2007, p. 357).

That farmers are not scientific but moved to invent by curiosity, chance or the need to solve a problem or adapt to changing conditions (Bellon, 2001, p. 4) associated with their farming activities suggests their informal trial and error approaches have much in common with the user

innovation processes described above. Trial and error approaches are also learning experiences and farmers are clearly engaged in the design and conduct of investigative projects, with cycles of critical reflection, planning and action, even if they do not follow scientific protocols. This points to the importance of tacit knowledge and social learning “*through changes in understandings and practices (where neither is prime)*” (see Figure 2.4; Ison and Collins, 2008, p. 7) which creates a type of situated knowledge and practice (Genat, 2009, p. 108), which some researchers are reluctant to acknowledge.

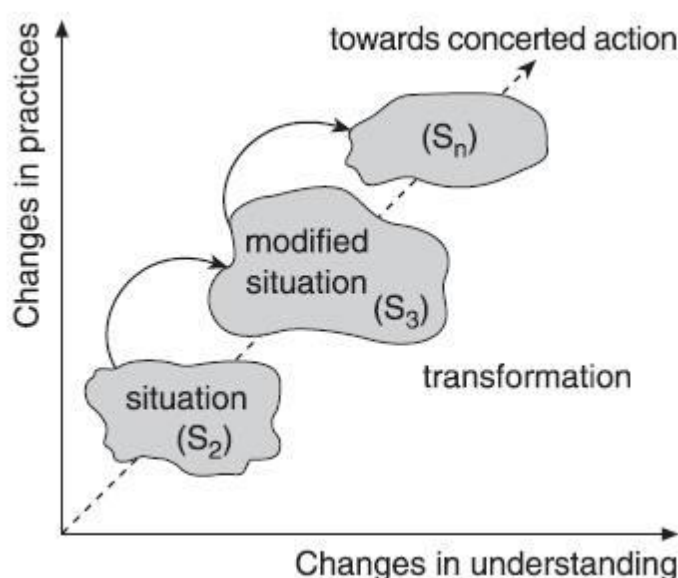


Figure 2.4: Heuristic for exploring the dynamic of transformational change, understood as changes in practices with changes in understanding (Ison and Collins, 2008, p. 7)

That said, there is a body of opinion, relating to participatory innovation development (see Wettasinha and Waters-Bayer, 2010, p. 27), that the involvement of farmers in research at an early stage would potentially involve a reciprocal knowledge flow between farmers and researchers, in order to deliver enhanced “*user-driven innovation*” (European Commission, 2012, p. 109) and a “*sustainable innovation culture*” (p. 21). Sumberg et al. (2003, p. 751) investigated the potential for joint research between scientists and farmers on the basis that while there is

sufficient homophily to support collaboration, there is also sufficient heterophily to bring forward creative potential and make the co-creation of new knowledge feasible. While acknowledging that farmers are active in experimentation, they found that *“farmers’ research is probably best seen as a partial substitute for the adaptive end of the formal research spectrum, having particular value in the final specification - or adaptation - of technologies to the diversity of local conditions”*. More recently, the Agricultural Research for Development (AR4D) approach, drawing on understandings of user innovation, is attempting to reframe the role of and mechanisms for user feedback earlier in the innovation development process, in order to improve the final product (Sumberg et al., 2013, p. 235). While the move towards greater user involvement in AR4D is a positive development, it does not seem to fully recognise the potential of farmers’ own innovations, the topic of this thesis, and as recognised in other sectors (above) where users are working together to research, develop, and produce new innovations in their area of interest without outside involvement.

Further, there are applied research facilities owned by independent farmers’ organisations, for example the Swedish Rural Economy and Agricultural Societies (SREAS, nd) or Local Agricultural Research Committees (CIAL - Centro Internacional de Agricultura Tropical) in Latin America which link farmer researchers with the formal research system (Braun et al., 2000, p. 33). The literature also describes mechanisms (local and global, face-to-face and virtual) that elicit farmers’ inventions. These include competitions (Macken-Walsh et al., 2012, p. 11), innovation circles (Wu and Pretty, 2004, p. 83), and programmes such as PROLINNOVA (Wettasinha and Waters-Bayer, 2010, p. 1), and the European Innovation Partnership (EIP) for Agricultural Productivity and Sustainability. Farmers’ involvement in research and development faces resistance from some professional researchers, yet a current NGO initiative in the UK is very promising. The Innovative Farmers network supports farmers in their practical experiments, generally relating to agricultural practices, by convening groups of farmers with shared interests and then matching them with a researcher. The farmers initiate the process and are supported to apply for research funding, with learning shared online (Innovative Farmers, nd).

There are also repositories for information and knowledge about farmers' user innovations in the print media (for example, Practical Farm Ideas magazine) and websites (for example, FarmHack or the Honey Bee network). There is little analysis of these innovations in terms of type, degree of commercialisation, or of the type of farmers who invent and the networks to which they belong. The free revealing of the inventions in magazines and online, a feature of user innovation, suggests that not all farmers are seeking to profit from their ideas, yet not all farmers share. The absence of institutional structures, such as local networks or incentives to record innovations, is said to create an "*indifference trap*" whereby farmers lack impetus to pass on their knowledge and ideas (World Bank, 2006, p. 2). The next section of this literature review discusses different concepts of knowledge and the generation and sharing of knowledge.

2.4 Farmers' Knowledge and Social Learning

We have seen that innovation in various sectors derives from knowledge combinations and re-combinations by people with very different levels of formal research and development expertise. In this section knowledge is approached as both an economic resource (Lundvall and Johnson, 1994, p. 27) and a product of social learning, constituting an integral part of the user innovation process, such that the user-innovators' knowledge is embodied in the final product and shared between users.

2.4.1 Types of Knowledge

The literature sets out many ways of characterising knowledge and, here, Lundvall and Johnson's (1994, p. 27) typology of "*economically relevant*" knowledge, which features in the management (Garud, 1997, p. 7) and agricultural systems literature (see Morgan and Murdoch, 2000, p. 159; Klerkx and Proctor, 2013, p. 15), presents an operationalisation of knowledge relevant to my topic. Four ideal type knowledges are identified at the individual level:

- Know-what: information, empirical knowledge of facts;
- Know-why: the knowledge of scientific principles and theories, learning-by-studying;

- Know-how: skills or capability to do something, learning-by-doing;
- Know-who: social skills to access the know-how of others, including the know-when and know-where of market intelligence; a form of social capital (Lundvall and Johnson, 1994, p. 28).

These knowledges are seen as complementary and interactive (Klerkx and Proctor, 2013, p. 15) and most people will possess all of them in different situations and relational settings, for example, occupational expertise could be said to encompass all four types in varying degrees. The following two theoretical approaches to knowledge inform my analysis. Firstly, a philosophical perspective is Polanyi's (1962, p. 2) characterisation of knowledge as either "*tacit*" or "*explicit*". The distinction depends, first, on the degree of codification and, second, the "*requirement of presence in knowledge formation*" (Howells, 2002, p. 872). Explicit knowledge is standardised, written down and presented in blueprint-type documents, and does not require experience of the matter to understand (Howells, 2002, p. 872; Klerkx and Proctor 2013, p. 15). Comprising know-what and know-why, it is accessible, reproducible, and therefore marketable. Tacit knowledge, in contrast, is learned through practice and, being context-specific, is difficult to communicate in a codified way or commodify: "*there are things that we know but cannot tell*" (Polanyi, 1962, p. 1). Connected to skill, experience and individual perspectives, tacit knowledge is described as "*inherently intangible*" (Klerkx and Proctor 2013, p. 15) with important elements "*collective rather than individual*" (Lundvall and Johnson, 1994, p. 30). It is "*complementary*" to explicit knowledge (Johnson and Lundvall, 2001, p. 6) and variously described in the literature as indigenous, traditional, grassroots, peasant, or folk knowledge. Issues arising from the codification of tacit knowledge are explored further at sub-section 2.4.4.

Second, Tovey and Mooney (2006, p. 96) developed a sociological consideration of the dynamics of explicit and tacit knowledges in European rural development, including those relating to social interactions. Similar to Polanyi, they distinguish between knowledge that is codified and that which is practice-based, and identify four categories:

- “*expert*” knowledge: primarily identified with scientific, policy, or technological expertise; a type of standardised know-why “*pruned of its contextual references*” (Tovey and Mooney, 2006, p. 95) to apply across all local settings;
- “*managerial*” knowledge: know-what required to negotiate and manage the implementation of standardised expert knowledge within a local site (Tovey and Mooney, 2006, p. 95);
- “*lay*” knowledge includes unaccredited livelihood practices and expertise (Tovey, 2009a, p. 136), forming an important element of the rural repertoire. A type of know-how, it is acquired through social or experiential learning and observation. Not generally written down, it may lose relevance or become rigid over time (Garud, 1997, p. 10), be lost if market conditions or agricultural practices change (Tovey and Mooney, 2006, p. 97), or are disrupted (Garud, 1997, p. 10);
- “*tacit*” knowledge encompasses “*social relations and practices*” (Tovey, 2009a, p. 136) that enable an individual to operate skilfully in the community. It provides a source of trust and social capital to “*help to create environments in which useful empirical knowledges can be empowered and put to work*” (Tovey and Mooney, 2006, p. 100). This type of know-who is of relevance in knowledge communities (Duguid, 2005, p. 112), such as user innovation networks or communities of practice.

Tovey and Mooney (2006, p. 11) recognise that all the above knowledges “*differ only in the processes through which they are generated and constructed, transmitted, validated and certified*”, each being ‘expert’ in its own right. However, in the agricultural context, the power and status attached to different knowledge types is said to validate know-why (scientific knowledge) above all others. In Table 2.2 (below) the characteristics of the knowledge types (Lundvall and Johnson, 1994, p. 28) at the individual and institutional levels are set out, along with their relationships to the characterisations of Polanyi, and Tovey and Mooney. It is acknowledged that the analysis above presents a rather instrumental view of knowledge in that

it does not capture the context in which these knowledges are generated, or the values and motivations of the people involved; this is discussed further below.

2.4.2 Farmers' Knowledge

Given that there have been many years of agricultural education and extension, it is recognised that farmers' knowledge is not *"entirely unmediated by expert discourses"* (Tovey and Mooney, 2006, p. 96), notwithstanding that it is *"underpinned by a cumulative understanding that often stretches back over many generations"* (Riley and Harvey, 2007, p. 404). By the nature of their occupation, farmers are place-based which situates their knowledge in a social, cultural, natural, and economic geography that is *"shaped by place and constrained by distance"* (Howells, 2002, p. 873). Tovey and Mooney (2006, p. 99) find know-how to be *"embedded within specific 'territories': geographically and socially boundaried sets of relationships within which knowledges are accumulated and stratified, but also reproduced, renewed, created, shared, and exchanged"*.

Knowledge categories and characteristics				
Knowledge characteristics	Know-what	Know-why	Know-how	Know-who
Individual level competencies	Knowledge of information, facts.	Knowledge of scientific principles.	Knowledge of processes; skills to do something at practical level.	Social and communication skills to access know-how of others, includes co-operation.
Organisational level competencies	Shared information, databases.	Shared values and models of interpretation.	Shared routines and practices, including company stories.	Shared networks.
Knowledge form	Formal, written, standardised.	Formal, written, standardised, cumulative, predictive.	Informal, intuitive, context-specific, developed over time, experiential	Informal, often unconscious, context-specific.
As related to Polanyi (1962)	Explicit	Explicit	Tacit	Tacit
As related to Tovey & Mooney (2006)	Managerial	Expert	Lay	Tacit

Table 2.2 - characteristics of four types of knowledge, at two levels, and their relation to other knowledge characterisations. (Source: self, adapted from Garud, 1997; Lundvall and Johnson, 1994; Morgan and Murdoch, 2000; Johnson and Lundvall, 2001; Duguid, 2005; Tovey and Mooney, 2006; Klerkx and Proctor 2013).

The user innovation literature suggests that the majority of user-innovators rely on their existing knowledge, without involving external bodies, such as manufacturers (von Hippel 2007, p. 294), and are graduates of science or technology. However, most farmers in the European Union rely

on practical experience only, i.e. have received no formal agricultural training (Eurostat, 2014, p. 3; Table 2.3 below). This is suggested to be due to the older age profile of farmers in the EU, where more than half are aged over 55 years old (Eurostat, 2015, p. 25). In Ireland, in 2014, the average age of a farmer was 57 (Hennessy and Moran, 2015, p. 1). While Ireland has more trained farmers than the European average, including the UK where over 70 per cent of farmers have practical experience only (Eurostat, 2014, p. 3), the rate of training is almost static in the period 2005-2010. The importance of apprenticeships, agricultural shows, and skills competitions to the building of knowledge and skills in farming communities is emphasised in Sutherland and Burton (2011, p. 251).

Year	2005, per cent		2010, per cent	
	Ireland	EU-27	Ireland	EU-27
Practical experience only	69	79	69	81
Basic training	17	12	15	12
Full agricultural training	14	9	15	7

Table 2.3: Farm managers' highest training level, Ireland and EU-27, 2005 and 2010 (Eurostat, 2014, p. 3)

2.4.3 Knowledge and Power in the Agricultural Context

Howells (2002, p. 881) finds that issues of power do not often feature in the knowledge literature, yet they exist. Tovey and Mooney (2006, p. 9) examined the role of knowledge in relation to *“the power to produce a dominant interpretation or definition”*, and have identified that know-how presents a *“cultural challenge to the hegemonic scientific culture of (Western) modernity”* (p. 10). Rural modernisation has seen *“magical”* non-rational knowledge replaced by expert scientific knowledge (Mormont, 2003, p. 39) to the extent that scientific knowledge dominates agricultural extension processes and environmental governance regimes. Being *“based in domains of power, decision-making and control over nature”* (Tovey, 2009b, p. 113), it *“devalues local and lay knowledge”* (Tovey, 2009b, p. 119) and deems the public *“insufficiently educated to participate in decision-making”* (Tovey, 2009b, p. 113) and farmers to be *“particularly obstinate and unenlightened... in terms of their environmental practices”* (Tovey,

2009b, p. 108). It is also suggested that farmers' own innovations are often deemed insignificant or inappropriate by a system predisposed to ignore farmers (EU SCAR, 2012, p. 30). One very senior EU official is illuminating in this regard:

"We are interested only in scientific knowledge, not farmers' knowledge, which is really a matter of education. The research focus is knowledge generated mainly by scientists and then applied by farmers – not farmers as a source of knowledge." (Levidow and Papaioannou, 2010, p. 24).

None of the above should be taken to suggest that know-how and know-who be valorised to the exclusion of know-why and know-what, but to recognise that an imbalance exists currently between the status of the different knowledge types which is not good for science or society. Russell and Ison (2000, p. 15) call for a complementary and *"contextual science for rural R&D that will evidence greater coherence with the expressed needs of the day-to-day lives of the people involved"* wherein farmers' knowledge and innovations fruitfully interact with other knowledge groupings.

There is also a widespread, and ill-applied, view that rural people suffer what is termed a *"knowledge deficit"* (Tovey and Mooney, 2006, p. 99), that they are somehow backward in their understandings of science, technology, and business. This reflects the system-wide *"hierarchisation of knowledge in European society, in which local, non-standardised, non-credentialised knowledges are ranked at the bottom in status and power"* (p. 100). Further, lay actors that are *"self-taught... experts"* lack recognition in the formal knowledge hierarchy, according to Tovey and Mooney (2006, p. 40).

2.4.4 Codification of Lay Knowledge

The codification of lay knowledge could be described as the embodiment of know-how in know-what. From an innovation perspective, the codification or writing down of know-how is a way to enhance knowledge exchange about users' needs and the context of use, yet the cost of the transfer of information to manufacturers in a useable form can be prohibitive, as we saw above

(Lüthje et al., 2005, p. 963). Codified knowledge is also required to protect Intellectual Property through patents or trade secrecy. The codification of indigenous knowledge (IK) by transnational firms that seek to patent or take ownership of IP rights in order to exploit collective wisdom has led to global and national treaties aimed at the protection of IK for sustainable development (Dutfield, 2006, p. ix).

In their research into European rural development, Tovey and Mooney (2006, p. 98) found that the codification of know-how was not without its controversies. Producers of authentic local foods have to adopt new *“modern... scientifically acceptable”* methods in order to achieve certification. This renders the product arguably less authentic as the producers’ skills and experience are sidelined. This officially sanctioned downgrading of local knowledge signals the difference in status between different types of knowledge and those who enact them (Tovey and Mooney, 2006, p. 98). I now present a discussion on key elements of the social learning literature which will contribute to the analysis of knowledge sharing in user innovation networks.

2.4.5 Social Learning

I argued above that know-how is not generally written down and is shared within relational groups (Tovey and Mooney, 2006, p. 99). I take the position that knowledge, and by implication the invention artefacts that embody farmers’ knowledge, is *“intrinsically a socially constructed process”* (Howells, 2002, p. 873) and the process of knowing is therefore *“mediated, situated, provisional, pragmatic and contested”* (Howells, 2002, p. 872). The starting point for this section’s discussion of social learning as a social and historical process is Wenger’s (1998) social theory of learning. I recognise that there are many perspectives on learning, from across the disciplines (see Blackmore, 2007, for a theoretical overview), but for my purpose here the focus is conceptualisations of learning communities, following Wenger, that will aid my analysis of data relating to knowledge sharing in user innovation networks.

2.4.5.1 Communities of Practice

The community of practice model “*operationalises social learning and relates it directly to social structures and to the practices of participants in the process*” (Morgan, 2011, p. 100). Wenger (1998, p. 73) describes its three dimension as “*joint enterprise... mutual engagement... [and] a shared repertoire of communal resources*”. Members of the community, which may be formal or informal, engage with each other around shared practices (Wenger, 1998, p. 74) in order to help or be helped (p. 76). Through this mutual engagement the community negotiates its stated goal, or joint enterprise, which may not be formally discussed (p. 84), that arises from the community’s response to its context: they have to find a way to do what they do (p. 79). The community’s goal provides a means, through behavioural norms or rules, to ensure accountability and assess competence within the community, (p. 82). Over time the community builds a shared repertoire of routines, stories, symbols, ways of doing things, concepts etc. that expresses membership of the community (p. 82-3). These shared goals and understandings are dynamically and interactively renegotiated (p. 84) as the context evolves.

Community members are engaged in the ongoing negotiation of meaning of practices, including shared values and norms, which contributes to identification with other members. Group identity is intertwined with practice, which acts as a source of coherence, resulting in strong occupational identities in some cases (Wenger, 1998, p. 77; Ingram et al., 2014, p. 284). Writing of gender identity, Butler claims a performative element in that identity is “*instituted though a stylized repetition of acts*” (Butler, 1998, p. 529, original emphasis removed), which here can be related to the performance of practices within a group and to audiences from outside the group. An individual may have multiple and changing identities, that are more or less dominant, according to the context (Wenger, 2010, p. 6). The emphasis on identity in the community of practice concept distinguishes it from the connectedness of the network concept, although these two types of structuring processes can co-exist, according to Wenger (2010, p. 10). In this way members of a community of practice with shared identity are connected, yet networks do not always have shared identity and a commitment to group learning. Wenger (2010, p. 10) suggests

the relative strengths and weaknesses of the two concepts can counteract each other to enhance group learning, in that overly strong community ties can effectively close off a group to the new inputs which the weak ties of network connectedness can bring (Granovetter, 1973, p. 1376), while a group that is extensively networked may lack coherence and require community solidarity to stabilise and build shared identity. Critics of the community of practice concept claim that it is a *“simplistic and unrealistic answer to a complex issue”* (Andrew, 2008, p. 251) and a term that is so increasingly *“homogenised”* as to have lost its emphasis on situated knowledge (Amin and Roberts, 2008, p. 355). The literature is said to overemphasise the community aspect to the neglect of understandings of practice, despite community being the *“social locus”* of practice (Duguid, 2005, p. 109), while issues of power, trust, hierarchy, and difference are neglected (Roberts, 2006, p. 634). I discuss my experience of using the theory in Chapter 7.

Some communities of practice are said to function as social learning systems, being relational, self-organised, with dynamic boundaries, and the ongoing negotiation of identity and meaning: *“the history of practice, the significance of what drives the community, the relationships that shape it, and the identities of members all provide resources for learning - for newcomers and old timers alike”* (Wenger, 2010, p. 3). In practical terms, a community of practice could be a group of engineers coming together, in person or online (Eastwood et al., 2012, p. 12), for problem solving, brainstorming ideas, requests for information, knowledge mapping, seeking and offering experience, feedback and evaluation (Wenger, 2011, p. 1). Ingram et al. (2014, p. 284) find that social learning occurred in an organised permaculture community of practice through it acting as a knowledge repository (for both tacit and codified knowledge that is generated within the community) and a forum for debate about practices and meaning, as well as the reciprocal sharing of knowledge.

The sharing of information between community of practice members is a complex series of *“iterative, reflective, continuing interactions”* (Oreszczyn et al., 2010, p. 406) that *“leads to a change in the knowledge-base of an individual or group of individuals”* (Howells, 2002, p. 874). With regard to knowledge sharing relating to innovation, Franke et al. (2006, p. 309), in the

management literature, find that user-innovators with access to local support and resources are more likely to innovate. Similarly, engineers in firms will trade information about proprietary processes with their peers: *“know-how trading involves an exchange of valuable information between traders which is at the same time kept secret from non-traders”* (von Hippel, 1987, p. 297). He defines know-how as the *“accumulated practical skill or expertise which allows one to do something smoothly and efficiently”* (1987, p. 291). In the agricultural context, farmers’ interactions, i.e. talking and discussion, are a social norm in rural Ireland, providing an important platform for knowledge and information exchange that has its locus in the local pub, church, or livestock market (Cush and Macken-Walsh, 2016, p. 38) or within formal and informal groups relating to sport, religion, and farming (Cassidy and McGrath, 2015, p. 24).

When considering farmers’ knowledge it is difficult to define the local, proximal nature of know-how and know-who in terms of a level of analysis (such as parish, county, or region) or a spatial dimension (within a given distance). While farmers’ networks and the availability of mobile and internet communication greatly extend what we might understand by the term ‘local’, the degree of remoteness of a farmer’s physical location remains an influence on the accessibility of face-to-face interaction (know-how and know-who) and also information (know-what). This in turn affects opportunities for social learning, the *“process of iterative reflection that occurs when we share our experiences, ideas and environments with others”* (Oreszczyn et al., 2010, p. 406). These more distributed networks are discussed next.

2.4.5.2 Distributed Networks of Practice

A community of practice can be said to operate horizontally with strong internal ties between members, while links between communities that are dispersed beyond the immediate geographical context are conceptualised as networks of practice (Oreszczyn et al., 2010, p. 405). Ties between communities in the network of practice are weaker than in a community of practice but a strong, practice-based identity is retained. In this way the community of practice acts as a subset of the network of practice, which itself has stable links with other communities and

networks allowing access to a broader range of knowledge. Members of the communities in a network of practice may never meet but share practices, as in a professional organisation.

Farming is itself a distributed occupation situated in micro-enterprises¹ and Oreszczyn et al. (2010, p. 410) found that the ties between farmers involved in trialling GM crops and other farmers were weaker and more like a network of practice than a community of practice. The farmers shared a strong identity and exchanges of knowledge and information were possible. However, the network was not the only source of farmers' advice, Oreszczyn et al. (2010, p. 411) found that farmers use a range of sources, across all the networks and communities of practice they are part of, both farming and non-farming. The level of influence varies, with accountants and trusted research institutes, for example, as "*foreground influencers*" (p. 413); other farmers were a source of ideas and opinions, but were not seen as particularly influential by the farmers studied. These "*webs of influencers on practice*" (p. 415) comprise the farmer's social learning environment.

In this section, I have shown that know-how and know-who have economic, social and cultural dimensions and form a significant part of rural collective knowledge. Knowledge is shared in social learning groups, involving participation in community processes. Codified knowledge has greater status than that which is unwritten or context-specific and the lower status of know-how is apparent in the formal organisations that are supposed to support agricultural development. The next section of this literature review considers the economic, social, and cultural motivators of farmer-inventors.

2.5 Sociological Motivators for Invention: Economic, Social, and Cultural Capitals

Economic theories of innovation are increasingly recognising the importance of "*intangible factors*" for entrepreneurship (de Dominicis et al., 2013, p. 2326) and in the section following I present aspects of user innovation from a sociological perspective.

¹ An enterprise that employs fewer than 10 persons and whose annual turnover or annual balance sheet total does not exceed 2 million euro (European Commission, 2015b, p. 11).

2.5.1 The Forms of Capital - Function, Accumulation and Conversion

The motivators for farmers to create and subsequently share or commercialise their ideas are conceptualised here as being dynamically and interdependently driven by social, cultural, economic, and symbolic forms of capital, as set out in Bourdieu (1986, p. 241). Although there are later and, arguably, more accessible approaches to the notion of social capital, in particular Putnam (1995), these are less theoretically interesting for two reasons. First, Bourdieu's theory *"revolves around the exchange and transfer of capital types"* (Sutherland and Burton, 2011, p. 242), which fits the research problem with its sophisticated explanation of informal social mechanisms as well as their inter-relations with economic and cultural capitals, including tangible objects, such as technological artefacts. Secondly, Putnam (1995, p. 2) makes social organisations the focus of his theory, approaching issues of trust in civic society from a political science perspective, which Portes (1998, p. 3) describes as a *"conceptual stretch"*. The aim here is to examine the individual level, rather than the institutional, and key elements of Bourdieu's theory of capitals provide a more illuminating approach.

Nonetheless, Bourdieu's grand social theory has been much debated and criticised, including for being deterministic in omitting notions of individual agency in the face of dominating social structures (King, 2000, p. 424), vague (Sullivan, 2002, p. 147), and neglectful of gender issues (McLeod, 2005, p. 18). Despite this, it has been suggested that Bourdieu's theories can be reread as a general theory of change (Yang, 2014, p. 1537) and they retain their status, albeit contested, as fundamental to sociological understandings of social structures and are used widely in rural sociology.

Turning to Bourdieu's theory (1986, p. 243), he suggests that all forms of capital are reducible to economic capital, while cultural and social capitals provide hidden means of preserving and passing on economic value, within families or other groups, in order to maintain or improve social status. All capital conversions involve a cost of labour, time, or effort and the substitutability of capitals provides a non-monetary route to power and influence (Portes, 1998,

p. 2), while the locus of transmission in the family group brings an emotional aspect to capital conversions (Scheer, 2012, p. 213).

Capital conversion strategies are defined by an individual's internal dispositions or "*habitus ... a socially constituted cognitive capacity*" (Bourdieu, 1986, p. 255), including gender, class, history, culture, and values, with the result that strategies relating to conversion may be unconscious (Bourdieu, 1986, p. 252). The history internalised in one's habitus is reproduced in behaviour and practices, resulting from interactions with the social context (Scheer, 2012, p. 202). Farmers' values and behaviours have been the subject of research relating to decisions to adopt, or not, particular farming practices or innovations. The research attempts to identify points of leverage for policy-makers, authorities, and firms to influence or coerce, "*nudge ... [or] budge*" (Barnes et al., 2013, p. 456), farmers' decision-making (see also Gasson, 1973; Marra et al., 2003; Galt, 2013). Duesberg et al's (2013, p. 161) study of the smaller than anticipated uptake of an Irish forestry grant scheme concluded that farmers' complex value systems mean that meeting non-economic values seems to compensate farmers for lower profits. Their study found that only 21 per cent of farmers interviewed were seeking to maximise their income, while non-economic values, such as job satisfaction, family tradition, and control over the land, featured more strongly.

Applying a Bourdieusian analysis introduces a political perspective to this thesis by "*uncovering sources of power and illuminating reasons that explain social asymmetries and hierarchies*" (Navarro, 2006, p. 15). Writing about social change in rural Ireland, Crowley (2006, p. 44) finds that the conversion of cultural capital, i.e. the possession of qualifications, to economic or symbolic capital ensures that "*the system of domination is legitimised in a self-perpetuating circular manner*", which resonates with the discussion of knowledge hierarchies above. While this thesis is not obviously engaged with issues of economic class, the literature suggests there are issues of social status around farmers' inventions. It is relevant here to consider Bourdieu's (1986, p. 247) description of the standing of engineers (suggested here as analogous to the farmer-inventor) as "*ambiguous*". Engineers are in the dominated group if they do not own the

means of production and sell only the services or products that arise from their cultural capital; if they profit from the use of a particular form of capital they are seen as in the dominant group. In this way, the strategies around the sharing or commercialisation of an invention may involve motivators related to changing farmer-inventors' economic and social status, but they are not always obvious, as we shall see below.

2.5.2 Economic Capital

Economic capital is the value ascribed to material wealth, which may be institutionalised in the form of property rights, including Intellectual Property. A leading benefit arising from the conversion of capitals is an increase in the time available for labour or leisure. In contrast, Do It Yourself (DIY), a feature of some user innovation, is seen as *"cash savings of the poor, which are paid for in time"* (Bourdieu, 1986, p. 258), while a lack of economic capital may mitigate against exploitation of new ideas. Social and cultural capitals can be converted into economic capital (e.g. access to funding or markets), which is important to farmers as micro-entrepreneurs, and for those with entrepreneurial intentions for their inventions. In the farming context, entrepreneurship often refers to diversification, i.e. the development of new income streams outside an existing or intensified agricultural business, in the form of on-farm enterprises, such as value adding processing of produce, manufacturing, or tourism activities. An alternative is to seek additional income through off-farm employment, as the increasing number of part-time farmers attests (O'Gorman et al., 2012, p. 6).

The decision to start a new enterprise, or entrepreneurial intent, is found to be influenced by social-cultural factors. In a study of Irish farmers' entrepreneurial intentions, based on survey data, O'Gorman et al. (2012, p. 11) find that while there were lower levels of intent than in the wider population, role models, i.e. somebody who has recently started an enterprise, particularly where some form of mentoring between role model and future entrepreneur is involved, are an important influence. Higher levels of education were positively associated with intent, while farmers' prior experience of business was found to be less significant. Lack of resources and

market opportunities negatively influenced intent, while a lack of support appropriate to the farm family may also inhibit entrepreneurial innovation (McFadden and Gorman, 2016, p. 68). Personal perceptions and emotions are also said to affect farmers' business decisions (Katila, 2002, p. 188).

The entrepreneurship literature provides emotional explanations for certain behaviours associated with launching a new enterprise. Optimism, or the expectation of success (James and Gudmundsson, 2011, p. 1377), and positive perceptions of one's own entrepreneurial skills (Arenius and Minniti, 2005, p. 242) are linked to initiating new ventures. Passion (pleasure from engagement in meaningful activities linked to self-identity; Cardon et al., 2009, p. 515) drives perseverance to overcome obstacles and solve problems and is demonstrated in a positive attitude to failure, an important factor in sustaining interest through the trial and error stages of the development of an idea. However, passion can tip over into unhealthy behaviours, such as obsession, over-confidence, risk taking, and *"unwavering belief in a dream"* (Cardon et al., 2009, p. 511). In terms of personality traits, Schiebel (2002, cited in McElwee, 2012, p. 67) suggested that entrepreneurial farmers differ from others in three ways. They have "more belief in their ability to control events; problem-solving abilities; and show social initiative (expressed through dominance, liveliness and social skills boldness)". An individual's personal disposition, their emotional engagement, and their circumstances, including prior knowledge and access to role models, may be important influences on farmers' perceptions of the viability of a new enterprise. An absence of support may constrain entrepreneurial intent, while entrepreneurs may also face overt hostility from others in their field.

The literature on entrepreneurship in firms identifies envy, *"the desire for another's possessions"* (Biniari, 2012, p. 142), arising from non-entrepreneurs' *"negative upward social comparison"* (Biniari, 2012, p. 142), as an obstacle to innovation which manifests in resentment, criticism, refusing to collaborate, group conflict, and, even, sabotage (Biniari, 2012, p. 159; Sathe, 1989, p. 21). Farmers are not immune to envy, despite their embedded social networks and evidence of mutual aid. Studies in sub-Saharan Africa linked envy to rates of innovation adoption (Kebede

and Zizzo, 2011, p. 29), farmers being singled out for attention by official organisations (Kiptot et al., 2006, p. 173), and a failure to share resources in order to maintain commercial advantage (Davis et al., 2004, p. 55). In the Irish context, this kind of peer resentment has a specific term, 'begrudgery' (de Pillis and Reardon, 2007, p. 385).

In a longitudinal study comparing Irish and American entrepreneurial intent, de Pillis and Reardon (2007, p. 385) describe begrudgery in Irish attitudes toward entrepreneurship as risk-averse, lacking respect, intolerant of failure and resentful of success, resulting in bureaucratic obstacles to entrepreneurship. This, they suggests, stems from cultural factors to the extent that Irish entrepreneurs need to be able to resist normative pressure and *"may require rebelliousness"* (p. 394). Hardiman et al. (2004, p. 4) find begrudgery also *"denies the legitimacy of public approbation to successful people"* and that its roots partly lie in Ireland's post-colonial economic struggles. The period of expansion in Ireland's 'Celtic Tiger' economy saw an increase in entrepreneurship and a move to more favourable attitudes (Hardiman et al., 2004, p. 22). Writing in the post-Celtic Tiger period, O'Gorman (2015, p. 16) proposes that a *"misalignment of incentives, such that entrepreneurial activity has been directed into unproductive, and what recently might be considered, destructive rent-seeking behaviours"*, rather than cultural factors, might be responsible for Ireland's economic travails. He also identifies a further change in public attitudes to entrepreneurship, citing a significant majority to believe that successful entrepreneurs have a high status.

2.5.3 Cultural Capital

Cultural capital is convertible in certain conditions to economic and social capital, and, by creating social value, can distinguish its owner from their peers: *"any given cultural competence (e.g., being able to read in a world of illiterates) derives a scarcity value from its position in the distribution of cultural capital and yields profits of distinction for its owner"* (Bourdieu, 1986, p. 245). Cultural capital occurs in three states: embodied, objectified, and institutionalised (Bourdieu, 1986, p. 243), these are discussed in the following sub-sections.

2.5.3.1 Embodied Cultural Capital

Embodied cultural capital represents “*dispositions of the mind and body*” (Bourdieu, 1986, p. 243), such as skills, knowledge (including scientific, technical), agricultural practices, as well as accent, manners, and emotions. In the case of farmer-inventors, the tacit knowledge and skills involved in the creation of invention artefacts require time and effort to acquire and are not easily passed on outside their learning community. The invention artefact represents the physical embodiment of the farmer-inventor’s knowledge and skills which may be exposed to the critical gaze of other farmers.

Burton et al. (2008, p. 20) suggest three necessary conditions for the display of embodied cultural capital by farmers:

- an activity that requires a “*skilled role performance*”, where performance can be assessed;
- the farmer’s skills must be “*manifest in the outcome of the activity*”, e.g. condition of livestock;
- “*outward signs of skill must be visible or otherwise accessible*” to other farmers, e.g. visible from the road.

Farmers display their embodied cultural and economic capital to other farmers through the quality of their livestock and machinery, as well as the state of their fields, in so-called “*roadside farming*” (Burton, 2004, p. 203). Local farmers will use their own embodied cultural capital to judge another farmer’s economic capital, by observing the quality of their crops and livestock; embodied cultural capital, by observing their farming practices; and objectified cultural capital by observing their farm machinery (Burton, 2012, p. 64; Sutherland and Burton, 2011, p. 243). As discussed above, displays of knowledge and skills can also be a way to establish group identity through the performance of the shared repertoire of practices.

The application of normative “*good farming*” criteria (Burton et al., 2008, p. 22) can mean that farmers who change their approach to farming face resistance from their peers. Farmers who

wish to convert to organic farming or significantly change farming practices, e.g. adoption of reduced tillage systems (Ingram, 2010, p. 193), often face criticism from other farmers locally who perceive such changes to be a criticism of conventional farming (Lund et al., 2002, p. 260). The presence locally of pioneer farmers means it is more likely that a farmer might adopt a new approach, called the *“neighbor [sic] effect”* (Risgaard et al., 2007, p. 452). For Irish farmers, the decision to convert is *“strongly influenced by the opinion of others”* to the extent that *“farmers are reluctant to engage in the behaviour of which others disapprove”* (Läpple and Kelley, 2013, p. 17), suggesting restrictive social norms.

The risk of negative peer responses also applies to the adoption of new technologies, Rogers (2003, p. 318) suggests that restrictive social norms lead to *“suspicion ... and disrespect”* towards innovators. Pioneering farmers in Ireland acknowledge the *“social implications of experimenting with new technologies, and how they occasionally met with sceptical attitudes from their peers”* (Macken-Walsh et al., 2012, p. 11). However, any negative effect was tempered for those farmers with previous experience in trying new ideas. They *“felt secure in their ongoing experimentation”* (Macken-Walsh et al., 2012, p. 12) and were not unduly troubled by their peers’ responses; the enjoyment of trialling new ideas and the discussion with peers about their experiments outweighed any concerns. Further, some pioneering Irish farmers, as a direct result of their social status in their communities, develop solutions (including inventions) to common problems (Shutes, 2003, p. 78). In New Zealand, a different set of good farming criteria has developed, partly in response to thirty years of neoliberal and deregulated agricultural policies. Hunt et al. (2013, p. 15) found that farmers’ good farming practices now incorporated more managerial approaches to costs, efficiency and new technology, driven by self-interest or economic rationality, to the extent that it forms part of their farming identity.

Turning to likely responses to farmer-inventors, the literature suggests that, in sub-Saharan Africa, some are considered *“so eccentric that they repel more ordinary neighbours”* (Critchley and Mutunga, 2003, p. 145), while Vanclay et al. (2006, p. 73) identify a number of labels that are applied to Australian farmers by their peers, arguably as a form of *“social control*

mechanism". Of relevance here is the "tinkerer" label (Vanclay et al., 1998, p. 117) that is attached to farmers who:

"spend all their time in the shed. They would rather make a new machine or modify an existing one than buy a new one ... they spend so much time tinkering that it often impinges on the time they should be spending doing other important farming tasks... Generally this group is admired for their mechanical skills".

Interactions between farmers and their peers, over daily farming practices as well as inventions, build social capital between farmers of similar embodied cultural capital, i.e. similar levels of understanding and skills, and, by implication, economic capital (Bourdieu, 1986, p. 249). These interactions may also be detrimental to the farmer-inventors' capital conversion strategies if inventing behaviour is not valued.

Embodied cultural capital is not restricted to the value ascribed to occupational knowledge and skills. Emotions can be regarded as social practices, which underpin and make more potent the norms and values that act as motivators to action (Katila, 2002, p. 191). The appropriateness of emotions is determined by the social structures within which an individual operates (Scheer, 2012, p. 202). We saw that entrepreneurial behaviour is driven by emotions of passion, optimism, and positive self-regard, which can tip over into unhealthy obsession and risk-taking. Other emotional spurs, such as love for family and commitment to the farm, are also found to affect farmers' decision making. A strong sense of duty to honour previous generations by maintaining the family farm, means that, in the breach, the farmer may experience shame, guilt, and distress (Bryant and Garnham, 2014, p. 311; Katila, 2002, p. 188). The literature relating to Irish farmers' relationship to the land, discussed in Chapter 1, also suggest a strong emotional element which affects their behaviour in that they are found to go to great lengths to ensure farm family survival by prioritising the financial stability of the farm (McDonald et. al. 2014, p. 27). As with farming practices, there are strong social norms which amplify culturally appropriate emotional responses and seek to control those deemed to be in violation (Katila, 2002, p. 188).

2.5.3.2 Objectified Cultural Capital

The cultural capital objectified in the invention requires economic capital to buy (or copy) and embodied cultural capital to use or appreciate (Bourdieu, 1986, p. 246). Objectified cultural capital is a concept that is most often associated with cultural products, such as paintings, yet Bourdieu specifically refers to scientific and technical cultural capital in relation to machines, while Burton et al. (2008, p. 22) refer to agricultural buildings, machinery, livestock, and crops.

2.5.3.3 Institutionalised Cultural Capital

An official mark of competence is a powerful means to confer recognition on an individual (Bourdieu, 1986, p. 248). Known as institutionalised cultural capital, this type of formal validation also allows for comparison between similar individuals, for example through educational qualifications (Bourdieu, 1986, p. 248) or prizes at agricultural competitions (Macken-Walsh et al, 2012, p. 11). This enables cultural capital to be converted back to economic capital through the labour market (in the case of educational attainment) or material objects (through competitions), although the conversion rate will depend upon scarcity, among other factors (Bourdieu, 1986, p. 248). In 2015, there were three national farming invention competitions in Ireland: the Teagasc Innovation Awards (open entrance, includes rural development ideas), the National Invention Competition at the Tullamore Show (open entrance), and the Innovation Zone at the National Ploughing Championships (selected entry, market-ready products).

2.5.4 Social Capital

Social capital is intangible and comprises two parts: the social relationship that allows an individual access to another's resources, and the resources themselves (Portes, 1998, p. 3). Building and maintaining social capital requires an investment of both economic and cultural capital over the long term (Portes, 1998, p. 4), but access to the resources of a group, through reciprocal exchanges, provides a "*multiplier effect*" (Bourdieu, 1986, p. 249) to the resources donated by the individual. While the motivation for receiving resources is evident, donor motivations are said to include shared norms, identity, trust, and reciprocal obligations (Portes,

1998, p. 5). Social capital gives access to resources such as: embodied cultural capital, e.g. expert advice; institutionalised cultural capital, i.e. institutional affiliation (Portes, 1998, p. 8); market information and business contacts (Gergs, 2003, p. 38), and, in the case of farmers, farm labour and machinery (Sutherland and Burton, 2011, p. 243). Investment in social capital therefore brings multiple benefits for the individual; social capital is convertible, in certain conditions, to economic capital, e.g. loans, and may be institutionalised as symbolic capital, in the form of a title or award (Bourdieu, 1986, p. 243). In this way social capital groups share some features of social learning groups such as reciprocal exchanges and common practices leading to shared knowledge and identity (Oreszczyn et al., 2010, p. 405).

The social capital group may be informal or formal, and membership will be limited. Occasions and practices are used to reinforce involvement, while accents and dress may indicate affiliation (Bourdieu, 1986, p. 256). Social capital group ties include: family history (Bourdieu, 1986, p. 249), shared cultural heritage (Burton et al, 2008, p. 20); and ethnicity (Portes, 1998, p. 9). Social capital groups can extend beyond the local area, but for farmers "*contingent relations*" (Bourdieu, 1986, p. 249), i.e. proximal neighbour relations, are an important source of social capital. Such relationships rely on ongoing exchanges and positive interactions, sometimes over generations (Sutherland and Burton, 2011, p. 242). Farmers will also get social benefits from the interconnected social networks found in rural areas, i.e. the same people appear in multiple networks, e.g. through kinship, friendship, work, sport, hobbies etc. This is seen in Balinese rice farmers who co-ordinate cropping patterns and fallow periods to manage pests, while sharing scarce water resources. The farmers' co-operation is organised through the physical and social networks of water temples (Lansing, 2005, p. 16), indicating the interdependencies of social capital. A number of studies also emphasise the importance of relationships to encouraging farmers' entrepreneurial behaviour (Bergevoet and Van Woerkum, 2006; Morgan et al, 2010; Seuneke et al, 2013).

However, the extent to which social capital in agriculture relies on the sharing of resources is changing. There is some evidence that competition between farmers has an effect on co-

operative practices. Curry et al. (2012, p. 247) find, in relation to knowledge networks, that *“there are natural limitations to such networks... when farmers feel that they are in competition with each other or when the information to be shared is commercially sensitive”*. To the same end Sligo and Massey (2007, p. 180) found that the absence of price competition enabled extensive day to day co-operation between New Zealand farmers as well as improved willingness to share knowledge and experience: *“farmers know they receive material, social and perhaps prestige-related benefits... being in constant communication with one another in a loose but effective system of mutual advice giving and support”*. In the same vein, a qualitative study of Scottish beef and sheep farmers found that day-to-day sharing of labour and machinery between farmers has declined (Sutherland and Burton, 2011, p. 252). This is explained through a Bourdieusian lens: that productivist values and the possession of economic capital, in the form of equipment and scarce labour, means that farmers will only share with those of similar embodied cultural capital and with whom they share social capital. The sharing occurs in limited circumstances, e.g. emergencies or work peaks, and involves machinery of low value, with labour commitments carefully monitored. Provision of labour or machinery at other times is carried out on a contract or like-for-like basis (Sutherland and Burton, 2011, p. 245). For Irish farmers, the commitment to survival of the family farm means that co-operation within farm households is viewed as a *“rational pragmatism”* (Cush and Macken-Walsh, 2016, p. 42), while the strong historical legacy of co-operation between farmers has adapted to rural restructuring, such that patterns of inter-farm cooperation remain strong (Cush and Macken-Walsh, 2016, p. 35).

As suggested above, one way that farmers build social capital is through mutual recognition of similar levels of embodied cultural capital. It can be difficult for small, remote, or part-time farmers to build and maintain sufficient embodied cultural capital (work is more hurried, so quality of livestock and land may suffer) and social capital (fewer opportunities to donate resources) to avail of shared resources (Sutherland and Burton, 2011, p. 246). Portes (1998, p. 11) found that limited or no social capital means little access to informal information, emotional support, or work opportunities, unless extensive family relationships are available to fill the gap.

Nor is social capital a panacea, *“sociability cuts both ways”* according to Portes (1998, p. 18) who sets out a number of drawbacks. Social capital groups can place limits on individual freedom and autonomy, due to group demands for conformity, while excessive claims on members, particularly those perceived as successful, can lead to them leaving the group in order to preserve their capital. In some groups downward levelling norms, i.e. group narratives of adversity or discrimination, are undermined by individual success stories, so ambitious members leave the group. Group norms may also lead to the exclusion of members who break the rules, outsiders, or newcomers.

2.5.5 Symbolic Capital

Symbolic capital arises when those with shared social understandings, or habitus, recognise the legitimate competence of any type of capital (Burton et al., 2008, p. 19), e.g. art collections, agricultural skills, trade shows (Gergs, 2003, p. 35). Symbolic capital differs from institutionalised cultural capital in that it represents recognition amongst peers, rather than the endorsement of an official body, which leads to prestige, reputation, trust, and confidence (Gergs, 2003, p. 34). Symbolic capital can be converted to economic capital, e.g. credit. In this way reputation and trust can be used to lever advantage in the market (Gergs, 2003, p. 34). In relation to farming, Burton et al. (2008, p. 23) suggest that *“all symbols of good farming ability relate to some extent to the economic efficiency of the farmer”* and, as we have seen above, good farming criteria may not extend to inventing.

2.6 Conclusions

We have seen in this literature review that the various innovation models involve the combination and recombination of knowledge, as embodied in innovation processes and outputs, yet user innovation uses sticky knowledge that is context-specific and not easily shared beyond the user community. Not all user-innovators are motivated by profit and the role of strategies relating to social and cultural capitals is recognised as a fundamental influence on farmers' inventing behaviours. Farmer user innovation is happening, yet it is under-researched

in more developed countries and unrecognised by parties in the formal agricultural research and advice systems. This bias against farmers' inventions is reflected in power relationships based in knowledge hierarchies and attitudes towards rural people, while other farmers may not regard inventing as a culturally appropriate activity. The productivist Agricultural Knowledge and Innovation System model discussed here does not recognise farmers as participants, but rather passive subjects to be acted upon to meet policy objectives. There is evidence that flows of knowledge remain largely in one direction, from formal organisations to the farmer. Farmers' knowledge, acquired through social learning and observation, informs and is informed by the research they carry out. Some seek spaces in user innovation networks to share their knowledge and innovations with others, although the majority go unrecorded. While some innovations are specific to their social and cultural contexts, the codification of farmers' knowledge allows sharing beyond place-based geographical limits and, in certain cases, opportunities for commercialisation.

Overall, two themes emerged from the literature review relating to the need for, first, a sustainable and resilient knowledge and innovation culture in agriculture and, second, recognition of the influence of individual farmer's subjectivities on their decision making and inventing. However, the review also indicates that farmers' inventions are neglected by the formal organisations in the AKIS, in contrast to the participatory direction of the literature. The aim of this research is to contribute to addressing that gap in the literature and to contribute to knowledge by drawing together these themes as they relate to farmers' inventing activities. It is clear that farmers will go on researching and creating new knowledge, and at a time of economic uncertainty and environmental concerns, this represents a missed opportunity to elicit and develop farmers' knowledge and innovations for positive economic, environmental, and social benefits. In the following chapter I set out the methodological approach taken in this thesis, including research questions, theoretical framework, qualitative and quantitative methods, and ethical considerations.

Chapter 3 - Methodology

3.1 Introduction and Research Question

In designing the research methodology for this study of user innovation in Irish agriculture, I return to my research aim, which is to investigate the inventing activities of farmers: their economic, social, and cultural motivators, the process and its outputs, and the learning communities involved. The strategy is to study the invention process at the farm level, with a focus on farmers and their subjectivities, as well as the tangible inventions themselves, with the result that we learn about user innovation from the farmers' own perspectives. This involves consideration of social and cultural, as well as economic, factors. This study focuses on artefactual inventions as a means to start to build our understandings of farmers' invention processes, while recognising that they exist in a broader sphere of innovation, which includes process and social innovations.

This research framework evolved over the stages of data collection and analysis, and followed discussions with supervisors, and researcher reflection. As well as the theoretical and analytical frameworks, the process of selecting data sources, the data collection and analytical methods used, researcher reflexivity, and ethics are addressed below. First, the research design needed to engage directly with the following overarching research question:

How do the motivators of Irish farmers influence their approach to the invention process and what are the outputs and the learning communities involved?

This research question and the relevant sub-questions (see Table 3.1) have changed over the course of the project. The original question was concerned with the invention process, particularly knowledge creation and sharing, as well as the farmer-inventors' motivators. It was not until after the first literature review that the interesting perspectives offered by the social learning literature and Bourdieu's theory of capitals (1986) were drawn to my attention. I had also planned to use and collect data upon some novel participatory methods with the farmer-inventors, but that part of the research design had to be redrawn once I was in Ireland, and the

key informant and farmer-inventor interviews were substituted; Table 3.1 sets out the data collection methods, which are discussed later in this chapter, by research sub-question.

Table 3.1: Main Research Question and Sub-Questions, with Data Categories and Sources (Source: Self)

Overall research question: <i>How do the motivators of Irish farmers influence their approach to the invention process and what are the outputs and the learning communities involved?</i>	
<i>Sub-question</i>	<i>Data categories and collection method</i>
<i>RSQ1: What are the characteristics of farmer-inventors?</i>	What is their farming enterprise (content analysis) Where are they located (content analysis) What is their educational attainment and experience (key informant, farmer-inventor interviews) What knowledge and skills are involved in inventing (content analysis, key informant and farmer-inventor interviews)
<i>RSQ2: How do farmers approach the invention process?</i>	How do farmers progress their ideas from initial problem identification to finished product (key informant and farmer-inventor interviews) What farm activities are the focus of farmers' inventions (content analysis, key informant and farmer-inventor interviews) Does the farmer-inventor work alone (content analysis, key informant and farmer-inventor interviews) What sort of artefacts do farmers in Britain and Ireland invent? (content analysis, farmer-inventor interviews) What are the characteristics of the inventions (content analysis, key informant and farmer-inventor interviews)
<i>RSQ3: To what extent are farmer-inventors motivated by economic, social, and cultural factors?</i>	What values and emotions underpin their inventing behaviour (key informant, farmer-inventor interviews) How do farmer-inventors view other farmers (key informant, farmer-inventor interviews) How do farmers respond to other farmers' inventing behaviour (key informant, farmer-inventor interviews) How does their inventing reflect their social status (key informant, farmer-inventor interviews)
<i>RSQ4: Do farmer-inventors have entrepreneurial intentions for their inventions?</i>	How often are inventions commercialised (content analysis; key informant, farmer-inventor interviews) What are the constraints and opportunities to commercialisation (key informant, farmer-inventor interviews)

<p><i>RSQ5: To what extent do the ties between farmer-inventors and their informal networks represent a social learning community?</i></p>	<p>How do farmer-inventors' informal networks function (key informant, farmer-inventor interviews)</p> <p>Who else is involved in the network (key informant, farmer-inventor interviews)</p> <p>What motivates farmers to freely reveal their knowledge and inventions within their network (content analysis, key informant, farmer-inventor interviews)</p>
<p><i>RSQ6: What is the state of the farmer-inventors' relationships with the formal organisations in the Irish Agricultural Knowledge and Innovation System?</i></p>	<p>What interactions do individual farmer-inventors have with AKIS actors (key informant, farmer-inventor interviews)</p> <p>How do individual farmer-inventors view the formal organisations of the AKIS (farmer-inventor interviews)</p> <p>How effective is the AKIS in supporting farmer-inventors (key informant, farmer-inventor interviews)</p> <p>How might this be improved (farmer-inventor interviews).</p>

Table 3.1: Main Research Question and Sub-Questions, with Data Categories and Sources (Source: Self)

3.2 Theoretical Framework

3.2.1 A Multi-Perspective Approach

The methodology here is based upon two particular positions: first, ontological, that is the nature of the reality to be studied (Bryman, 2012, p. 32). Second, epistemological, that is the nature of “acceptable knowledge in the discipline” (Bryman, 2012, p. 27), as captured in the relationship between the “knower and the known” (Packard and Conway, 2006, p. 265). In proposing knowledge and inventions as social constructs, with the farmer’s knowledge and experience embodied in the invention artefact, an interpretivist epistemology, which “requires the social scientist to grasp the subjective meaning of social action” (Bryman, 2012, p. 30), and constructionist ontology, that views “social objects and categories ...as socially constructed” (Bryman, 2012, p. 33), appear most fitting. A positivist epistemology would not be appropriate in this case as the positivist worldview promotes the objective application of methods of the “natural sciences to the study of social reality” (Bryman, 2012, p. 28) and the overarching philosophy here is interpretivist, constructionist, and reflexive.

This study uses both qualitative and quantitative methods in a “*multi-dimensional*” qualitatively led, rather than mixed methods, research strategy (Mason, 2006, p. 10), in which the quantitative data is presented as “*quasi-statistics ... a simple counts of things*” (Becker, 1970, cited in Maxwell, 2010, p. 476). Numerical data is not regarded as “*incompatible with a constructivist stance*” (Maxwell, 2010, p. 475), the aim is for it to complement and add substance to the qualitative data, by allowing different patterns and layers of data to be surfaced. Arising from the economic and management disciplines, the user innovation literature relies heavily on surveys and the use here of descriptive statistics will aid dissemination in that arena. However, this study goes beyond consideration of economic perspectives for it has, as its main focus, farmers’ subjectivities and motivators, following the sociological literature which proposes theories of social and cultural influences on farmers’ behaviours. I also use elements of social theories of learning and the farming systems literature to look at farmers’ expertise and their learning communities and to frame the part of the analysis which relates to farmer-inventors’ interactions with the formal innovation support organisations in the Irish AKIS. This study therefore aims to present a multi-faceted picture of the economic, social and cultural dimensions of farmers’ inventions and the learning communities in which they are embedded.

The collection of both qualitative and quantitative data supports multiple perspectives on both intangible and tangible aspects of the research topic. Mason (2006, p. 11) finds that, in constructing our explanations, data “*can be explained in more than one way, depending upon the questions that are being asked and the theoretical orientations underlying those questions*”. In this way what is common but also “*the differences that make a difference*” (Ison, 2008, p. 248) can be made explicit without forcing data integration (as seen in mixed methods approaches), or ignoring puzzling or absent data. Denzin (2012, p. 85) suggests that this approach can move beyond distinctions of qualitative research as exploratory and quantitative research as confirmatory, to a kind of methodological bricolage (see Rogers, 2012, for an overview) similar to that which Ellingson (2014, p. 443) calls “*crystallisation*” and Mason (2011, p. 78) “*facet methodology*”.

In practical terms, this multi-perspective approach enables the research to approach farmers' knowledge and inventions in two ways: first, in relation to the tangible outputs of the process. Farmers' inventions as (measurable) objects that enter a field where inventions are seen in terms of their potential for economic benefits are considered using content analysis. A large sample (n = 210) of mainly British farmers' inventions gives breadth to the content analysis. Second, farmers' inventions are seen as the results of social interactions and thus utilise methods that investigate interactions and meanings of social phenomena using semi-structured and narrative interviews, involving a small number of key informants (n = 5) and farmer-inventors (n = 5) participants, for depth and richness. The two approaches are seen as complementary, enabling a more rounded understanding of the topic. It is worth acknowledging at this point that it might seem contrary to the constructionist ontology that the first stage of data collection (quantitative content analysis) separates the invention from its inventor and context. While I subscribe to the view that the knower and knowledge should not be not seen as separate (Wenger, 2010, p. 3), it was a necessary step for my own education, in order to get a sense of the kinds of things farmers invent. The data source reflects an instrumental approach to user innovation, yet the findings were also useful in designing the next stages of data collection.

3.2.2 Starting Point – Literature Themes

Two broad themes emerge from the literature review (see Figure 3.1), first, the need for innovation in agriculture to achieve policy objectives relating to climate change, food security and farm resilience, and second, the influence of individual subjectivities. In a time of economic recession and environmental concerns, farmer-inventors' knowledges, motivators, and inventions in more developed countries are largely unexplored in the literature. Research on user innovation is overwhelmingly from the economic and business disciplines, often based on survey methods, and there is little exploration of user innovation in agriculture. Equally, the international development and farming systems literatures consider farmers' inventions but mainly in less developed countries, a very different context to European agriculture. This is identified as the gap in knowledge that provides the focus for this project.

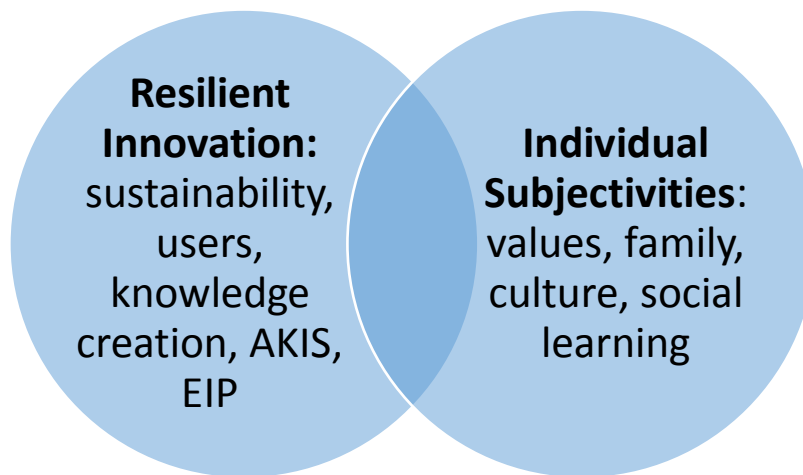


Figure 3.1: Two themes emerging from the literature review (Source: Self)

3.2.3 Research Focus

The research focus that emerges from the intersection of the two themes outlined above relates to farmers and their inventing practices, the economic, social, and environmental policy imperatives, and the institutional context in which they invent. Farmers' own subjectivities are an important influence on their approach to the invention process, including the decision to take the invention beyond the farm gate and whether to pursue commercialisation. Different types of knowledge, skills, and experience are combined and embodied in farmers' inventions. The sharing of knowledge and inventions in farmer-inventors' learning communities raises issues of status and agency, and can be described as relating to, but not formally part of, the AKIS.

User innovation theory (von Hippel, 2005) gives us a way to think about the outcomes of knowledge generation and combination from the economic perspective, and basic principles of the sociological literature (Bourdieu, 1986) the means to investigate the capital conversion strategies of farmer-inventors. These foci inform the analytical framework, while the AKIS model offers a framing device to present the relational aspects of farmer-inventors' learning communities and their interactions with formal research systems.

3.2.4 Theorising from the Data

The analytical framework aimed to explore and build the theoretical arguments that emerged from the data. It was not intended to impose categories, particularly on the qualitative data, but was a way to organise temporally the data that emerged to incorporate key topics of interest: the process aspects of invention and sharing, as well as the unfolding of life experiences, i.e. the farmers' subjectivities and motivators. The framework was also important for structuring the data for dissemination.

Silverman (2000, pp. 84-5) identifies a number of ways in which theory can be derived from the data by considering: chronology, i.e. changes over time; context, i.e. how particular settings or experiences affect the issue under review; comparison with other relevant data or subsets of the project data; implications, i.e. how the findings link to broader issues; lateral thinking, through exploration of the relationship between apparently diverse models or theories. In juxtaposing user innovation theory and Bourdieu's (1986) theory of capitals, I aim to explore how the economic, social, and cultural context affects farmers' inventing behaviours and the resulting implications for agricultural policy and practice.

3.2.5 User Innovation through the Lens of Bourdieu's Theory of Capitals

This thesis brings together two theories from different traditions in order to investigate economic, social and cultural perspectives of user innovation in agriculture. In this section I briefly discuss Bourdieu's theory of capitals (1986) alongside key elements of user innovation (von Hippel, 2005) in order to understand the articulation of these theories as they complement and diverge from each other in the data analysis.

User innovation describes a process of creation outside the firm that turns knowledge and other resources into useful products, while Bourdieu (1986, p. 249) posits strategies, which may be unconscious, i.e. based on deeply held values and beliefs, to improve a family or group's social status by converting economic capital to either cultural, social, or symbolic capitals. Regarding the invention process, it is possible to imagine the conversion of economic and embodied

cultural capitals into the completed artefact, which itself can be viewed as an instrument of capital accumulation. The user-innovator gains certain benefits, which may also be considered as forms of capital, directly from the use of the artefact (von Hippel, 2007, p. 294). The anticipation of such benefits could be said to act as a motivator to the investment of capitals in the invention. However, the user innovation process is not linear, it emerges from trial and error and may involve input from other users, so the capital conversion strategies may not always be obvious.

Free sharing of the invention in user innovation networks is a feature of user innovation yet is not considered a rational act if approached from an economic perspective but, like the commercialisation of an invention, may be approached from the Bourdieusian perspective. In this way the sharing or commercialisation of a user innovation can be analysed as capital conversion strategies. The user innovation network, within which an artefact may be freely shared, can be seen as a social capital group involving mutual exchange of resources, such as knowledge and skills. As a result of sharing their invention the user-innovator may or may not gain network benefits, which also can be considered as forms of capital. Commercialisation of the invention is a direct route to increasing economic capital. In this section I have shown how the bringing together of data relating to tangible and intangible aspects of user innovation enables a clearer understanding of both the farmer-inventor and their invention. I use this theoretical articulation in chapters 4, 5, and 6 that deal with the findings from this research project to identify where the two theories are congruent, and in Chapter 7 I discuss the implications of the findings for both user innovation and Bourdieusian theories.

3.3 Research Design and Stage 1 – Researcher Orientation

Figure 3.2 (below) illustrates how the research design, influenced by - but not fully implementing - the emergent aspects of Grounded Theory approaches, consists of consecutive stages whereby the data and analysis from earlier stage(s) feed forward to influence the approach at the subsequent stage, as well as building cumulative insights into the research questions (Table 3.1).

The sequence of the research stages allowed for my own understanding of the topic to deepen as it moved from immersion in Irish agriculture, through to immersion in the inventions themselves in Britain (content analysis) and Ireland (attending agricultural shows), to the organisational context of Irish farmers' inventing (key informant interviews) and, finally, hearing from the Irish farmer-inventors themselves.

My intention is for the findings to focus on the farmer-inventors' perspectives and, in order to minimise any undue influence on my thinking from the earlier data collection stages (magazine content analysis and key informant interviews), I sent the farmer-inventors their interview transcripts and a project update that summarised the findings for their comments. The, first, Researcher Orientation stage incorporates my immersion in Irish rural life and agriculture, described in section 3.8 on researcher reflexivity below, which formed an important part of this research process as a means to explore, prepare, and scope my research interests. In Stage 2 I collect data relating to British farmers' inventions in what I describe as a type of immersion in farmers' inventions which complements my in-depth engagement in Irish agriculture in Stage 1.

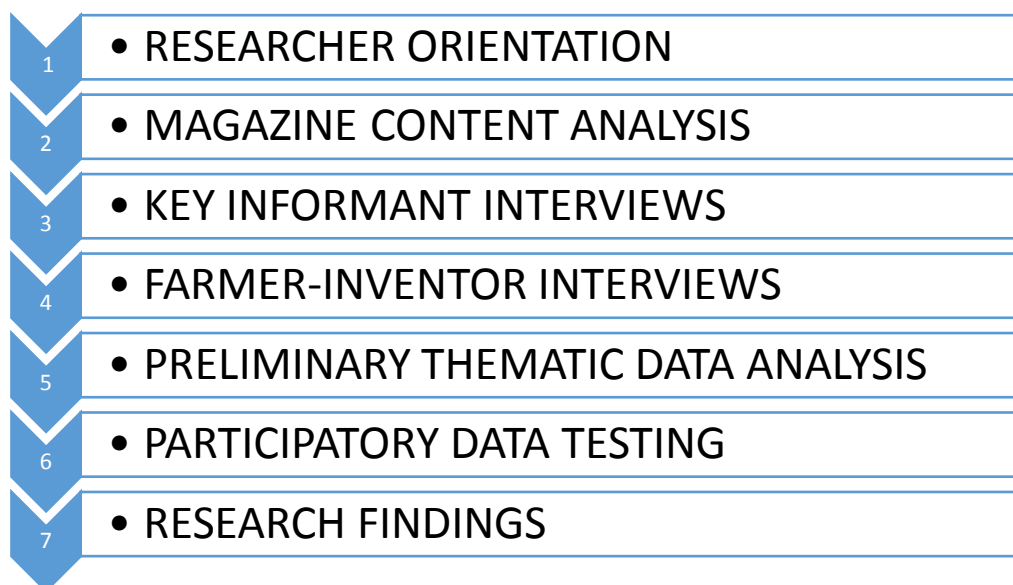


Figure 3.2: Research Stages with Data Sources and Research Methods (Source: Self)

I now set out how the stages of the research, relating to data collection, numbered 2-6 inclusive in Figure 3.2, might flow together coherently. By this I mean from the second to third stage, and

from second and third stages to fourth stage, and from the second, third, and fourth stages to the fifth data synthesis stage. The sixth data testing stage allowed the key informant and farmer-inventor participants, from their own perspectives, to challenge or confirm the research findings. The seventh and final stage involved drawing together the emerging themes into findings with implications for theory (see Chapter 7).

Notwithstanding the ontological points discussed above, I justify starting data collection with the magazine content analysis of the stories of individual inventions by drawing on Bruckmeier and Tovey (2008, p. 316) regarding the reverse knowledge cycle:

“preceding knowledge is required to organise methodologically the production of new data and information, and to interpret data and information, knowledge is also required, so that both hierarchies describe the whole process of knowledge generation”.

This suggests that my understanding of farmers’ inventing processes and behaviour will be supported by prior knowledge of the stories of farmers’ inventions in more developed countries, a type of immersion in inventions, complementary to my earlier immersion in agriculture.

In this case the inventions featured were from British farmers, which allows for some comparison with Irish farmers’ inventions given that they operate in the same policy and market environment (see Chapter 7). It is also recognised that using a magazine as the source for the first round of data collection might give undue influence to the perspectives of the Editor and the self-selecting contributing farmers in framing the problem for the subsequent stages of data collection and analysis. The magazine’s editor certainly approaches the inventions from an economic perspective (Donovan, 2014) and, in the subsequent data collection stages, additional data on social and cultural understandings act as a counterbalance.

In moving from the second to the third stage, the content analysis was found to be rigorous, subject to its limitations. The staged data collection approach allowed that the research design adapted to the previous stage’s data outputs and in the third stage of the research, the key informant interviews, the interview protocol was adapted to incorporate questions about the

type of inventions Irish farmers might produce, and photos from the magazine were used as prompts. Moving on to the fourth stage, narrative interviews with farmer-inventors, insights from the second and third stages influenced the selection criteria and the interview approach. The inventions analysed in the content analysis were almost entirely artefacts and it was decided that only farmer-inventors who had produced artefacts would be selected for interview. The key informants had described some of the innovation support available to entrepreneurial farmer-inventors and the interview approach sought to elicit their perspectives on this.

The forward feeding of data involved analysis after each stage of data collection and in stage 5 the data was synthesised into preliminary research findings using a thematic approach. The findings were then summarised in a project update document (see Appendix 1) in Stage 6, which was sent to all interview participants for their comments in what I call 'participatory data testing'. The pause for review between data collection stages meant that the research approach evolved according to the context; the sequence of data collection and analysis, including methods, is set out in figure 3.3 below. This investigation of farmers' invention processes and motivators involved a series of stages of data collection, a number of data sources, as well as different methods of data collection and analysis in a qualitatively-led research design.

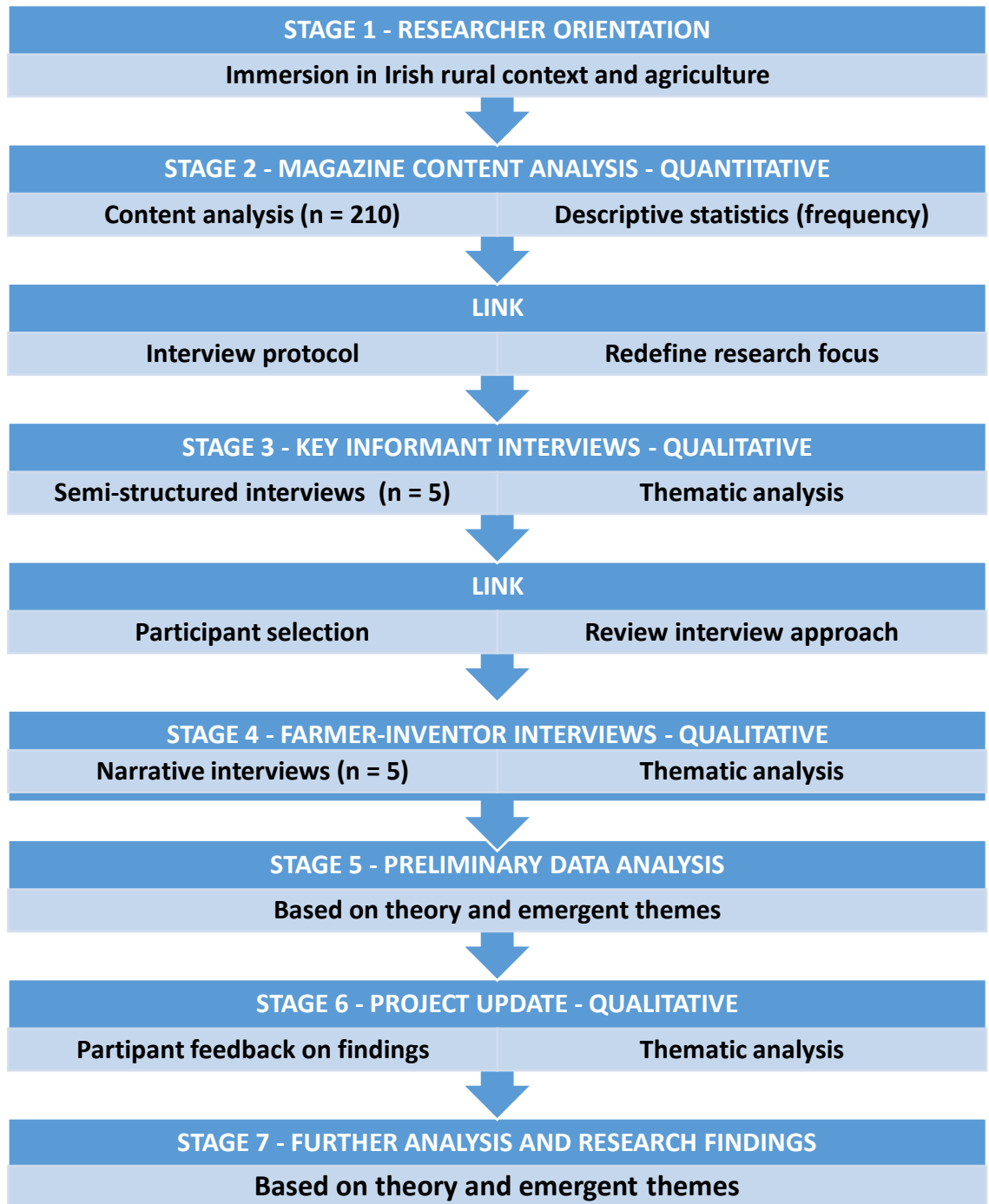


Figure 3.3: Sequence of stages of data collection and analysis, including methods (Source: Self)

3.4 Stage 2 - Content Analysis

3.4.1 The Content Analysis Method

This stage of the data collection provided an initial perspective on the stories of farmers' inventions to inform the subsequent research stages and, below, I set out my approach to the content analysis, including data population and sample, variables, and limitations. Content

analysis is defined as an *“approach to the analysis of documents and text that seeks to quantify content in terms of predetermined categories and in a systematic and replicable manner”* (Bryman, 2012, p. 290). The documents involved usually cover a range of mass media and communication sources, but can also include interviews or visual images (Bryman, 2012, p. 290). It is not considered an intrusive research method, in that the researcher is absent from the *“interactions or events being studied”*, such materials therefore are said to be free of any influence that might occur if the materials were intended for a research study (Webb et al., 1966, cited in Bryman, 2012, p. 325). That said, the documents to be analysed must be of a quality to provide useable data and the reliability of coding assessed.

Content analysis focuses on the presence of certain concepts, or variables, in the text using codes to categorise them, and has been described as the *“quantification of judgements”* (Kassarjian, 1977, p. 9). It has been described as *“atheoretical”* (Bryman, 2012, p. 307) in that the data alone are just measurements until linked to the researcher’s theoretical framework or the data’s context. The variable and code descriptions were derived from the research question and literature (see Appendix 2) and also as emerging from the data during coding and after analysis. By this I mean that new codes were added during coding relating to the location (USA, Canada) and sector (contractor) variables, while, following the analysis, some were renamed - while retaining their meaning - to better indicate the matter under scrutiny. For example, the ‘farm sector’ variable was renamed ‘farm enterprise’, and ‘bricolage’ code under Variable 4 renamed ‘architectural’.

By focussing on the stories of the inventions, I did not seek to draw conclusions about the writer or the audience. In general the presence of concepts in the text is straightforward to categorise, and is described as *“manifest content”* (Bryman, 2012, p. 290; Lombard et al., 2002, p. 589), in that it requires little interpretation. *“Latent content”*, on the other hand, lies beneath the surface of the text and requires coders to *“provide subjective interpretations based on their own mental schema”* (Lombard et al., 2002, p. 589). This study required the coder to consider both manifest and latent content; Table 3.2 below sets out the variables and whether manifest or latent.

As a method, content analysis is said to be “*objective and systematic*” (Bryman, 2012, p. 289) because it is transparent and can be replicated (Bryman, 2012, p. 304). The interpretation of latent content raises the issues of reliability, and in the case of a single coder intra-coder reliability, and how it is measured. Much of the critique of content analysis focuses on the lack of transparency in published articles about the degree to which reliability has been assessed and the methods used (Lombard et al., 2002, p. 594; Krippendorff, 2004, p. 411). However, issues of reliability do not only arise when latent content is analysed and in the next section the quality of the data source is considered.

Variable description	Nature of content
Variable 1: Activity – identifies the farming activity to which the invention relates.	Manifest
Variable 2: Benefits claimed for the invention (as identified in the story).	Manifest
Variable 3: Drawbacks of the invention (only if identified in story).	Manifest
Variable 4: Effect (novelty) of the invention	Latent
Variable 5: Use of the farmer’s existing knowledge and skills	Manifest
Variable 6: Form of invention.	Manifest
Variable 7: Use of ICT	Manifest
Variable 8: Farm enterprise in which the invention was made.	Manifest
Variable 9: Is the farmer seeking to commercialise their invention?	Manifest
Variable 10: Location of the farmer-inventor	Manifest
Variable 11: Year of magazine Issue	Manifest

Table 3.2: Nature of content (latent or manifest) in content analysis variables (Source: Self)

3.4.2 Practical Farm Ideas Magazine as a Data Source

Practical Farm Ideas magazine (PFI) is an editorial-only magazine that is published four times a year. Started in 1992 by a Welsh dairy farmer, who has experience as a journalist, it has around 12,000 subscribers. Farmers (mainly from the UK, with some from Ireland, the rest of Europe, and North America) submit their inventions for publication. The editor often visits the farm and gathers information about the invention directly from the farmer-inventor, as well as photographic images or drawings of the invention (Donovan, 2014). This means that the published story of the invention is based on the account provided by the farmer-inventor to the editor (either face-to-face or through correspondence) and as reinterpreted by the editor for publication. The stories describe (variously and not always consistently) the:

- purpose, description, and use of the invention, including its mechanical or technical specification;
- origin of the farmer's idea and its development;
- benefits and drawbacks of the invention;
- extent to which the farmer brought in outside help in the development process;
- cost of manufacture and materials;
- location and type of farm enterprise of the farmer-inventor;
- name and contact information, and
- the availability of the invention on the market and Intellectual Property protection.

This information formed the basis of variables and codes used in the content analysis and where the individual magazine story does not provide data for any of the codes this is indicated in the analysis.

Atkinson and Coffey (2011, cited in Bryman, 2012, p. 554-555) warn that many documents are created in a specific context, for a specific purpose and target audience, and with the intention of showing the originators in a good light. With regard to documents to be used as a source of data, Scott (1990, p. 6, cited in Bryman, 2012, p. 544) proposes four quality criteria:

“authenticity... credibility... representativeness ... meaning”. When these are applied to PFI magazine, it is found to be:

- Authentic: the magazine is genuine as it comes directly to the author from the publisher on subscription;
- Credible: there are two aspects to credibility discussed here. First, inventions are found to be accurately described, as far as can be ascertained. Most stories include visual representations (photographs or drawings) that confirm the description. Second, the disposition of the writer (Bryman, 2012, p. 298) could be described as enthusiastic about the benefits of the featured inventions, yet the stories also draw attention to drawbacks of the invention on occasion. Benefits and drawbacks were collected in the analysis;
- Representative: the 210 inventions comprise three years’ worth of the magazine (2003, 2008, and 2013) and are representative of the types of inventions submitted to the magazine, being artefacts for use in a wide range of farming activities and mainly from British farmers;
- **Not** representative regarding inventions: there are two areas of quality concern here. First, the inventions featured in PFI cannot be claimed to be fully representative of all farmers’ inventions as the submitted examples are selected by the farmer-inventors and further filtered by the editor before publication. Further, the inventions are from more developed countries, in particular Great Britain, and, in the absence of any extant literature, it cannot be determined if they are representative of those places or not;
- **Not** representative as a publication: Second, with regard to PFI as a publication, no UK or Irish publications have been found that address farmers’ inventions exclusively, or to the same depth as PFI, so the magazine could not be said to be representative of farming or invention publications. However, a number of general agricultural publications and websites internationally run regular features on individual farmer’s inventions and there

may be publications in other languages that provide similar material. Equally, general inventing journals and websites do not have a specific agricultural focus, but occasionally feature agricultural inventions;

- Meaningful: the journalistic style is found to be understandable to its intended farming audience, and is supplemented by visual representations; the contact details of the farmer-inventor, where provided, allow for further inquiry.

On these terms, PFI magazine can be considered a reasonably sound data source as long as its limitations regarding representativeness and editorial enthusiasm are borne in mind. This is not considered a major problem as it is argued that PFI occupies a niche in the agricultural and invention media that offers a particular and unique opportunity to study farmers' inventions in detail. Given the lack of research generally about farmers' inventions in more developed countries and the absence of alternative data sources, the magazine provides stories of British farmers' inventions and provides an opportunity for some basic comparison with Irish farmers and their inventions (see Chapter 7). Having established the magazine as a data source we now consider the sample to be analysed.

3.4.3 The Data Population and Sample Selection

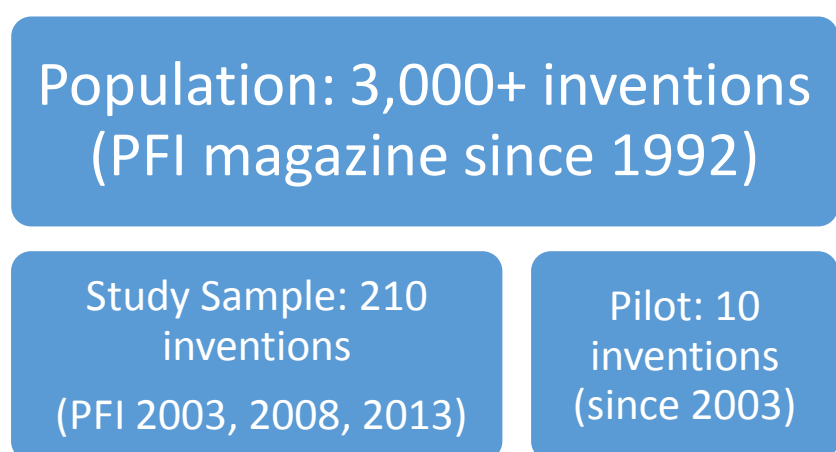


Figure 3.4: Relationship of the content analysis sample and pilot to the data population (not to scale)
(Source: Self)

The data population is the entire output of the magazine over 22 years (this part of the study was conducted in 2014), involving over 3,000 inventions. The documents under consideration in the study are stories from the magazine each describing one invention; each invention therefore is a unit of analysis, while the magazine issue is the observational unit (Dolma, 2010, p. 171). The study takes a date-based approach to sampling (Bryman, 2012, p. 293) and looks at three years' worth of the magazine (2003, 2008, 2013), featuring the stories of 210 inventions (approximately 7 per cent of the population) (see figure 3.4 for a schematic representation of the content analysis sample and population). This allowed some longitudinal analysis of the invention stories, in relation to patterns relating to, for example, the use of ICT. A flexible approach meant that, as issues emerged during the analysis, extra codes were added as required, as was the case with the 'architectural' code under Variable 4. This reflects the overall inductive approach to the study which allowed themes to develop through the different stages of the data collection and analysis.

3.4.4 What is Being Counted?

This content analysis contributes towards research sub-questions 1, 2, and 3, as set out in Table 3.3 below. The text of the stories was examined to provide information of interest about both the invention and the farmer-inventor using descriptive variables (Sapsford, 2007, p. 9). Each variable had a number of codes assigned that categorise the concept in more detail and relate to the research questions. While the stated aim of the study is a key factor in designing the coding scheme, the analytical techniques were also considered at an early stage. In this case the variables and codes are solely nominal, in that they do not infer *"influence or causality"* (Sapsford, 2007, p. 39). Some of the questions are dichotomous, containing two codes, while others allow multiple non-ranked responses. This enables univariate analysis which produces descriptive statistics, i.e. frequency, which can be presented as a bar chart or pie chart and, potentially, bivariate analysis to explore relationships (not causality) between variables (e.g. farm enterprise of origin and activity).

Research Sub-question	
<i>RSQ1: What are the characteristics of farmer-inventors?</i>	What is their farm enterprise Where are they located
<i>RSQ2: How do farmers approach the invention process?</i>	How do farmers progress their ideas from initial problem identification to finished product To which farm activities do the inventions relate What sort of artefacts do farmers in Britain and Ireland invent Does the farmer-inventor work alone What are the form and effect of the inventions
<i>RSQ3: To what extent are farmer-inventors motivated by economic, social, and cultural factors?</i>	What benefits are claimed for the inventions How often are inventions commercialised

Table 3.3: Research sub-questions covered in the content analysis (Source: Self)

The data was analysed using the SPSS software programme and the coding categories were found to be saturated, i.e. where “no new theoretical insights are being generated” (Bryman, 2012, p. 717), after 210 inventions, which is less than the 300 originally planned for analysis. The author was the single coder for the main study and intra-coder reliability testing took place on completion.

3.4.5 Limitations of the Content Analysis

The literature on research methods, along with the pilot study, identified a number of issues that could limit the reliability, and hence the validity of content analysis: code validity; inter-coder reliability; single coder systematic bias; single coder stability; representativeness; unit of analysis. Each of these issues is described below along with any corrective or regulating action.

First, the validity of the code design, i.e. the degree to which it reflects the concepts being measured. The codes were drafted bearing in mind what is said in the literature (see Chapter 2

above) about user innovation; farmers' inventions; innovation design, as it relates to the process of invention and the effect (novelty) and form of an invention. The codes were also subject to face validity testing (Bryman, 2012, p. 171) by six Teagasc agricultural students in the pilot study. This means that people with academic and practical knowledge of agriculture were asked to consider the degree to which the codes reflected their understanding of agricultural practice.

Second, inter-coder reliability or agreement, relevant only to the pilot stage, is a key indicator of consistency and replicability in content analysis: *"agreement is what we measure; reliability is what we wish to infer from it. In content analysis, reproducibility is arguably the most important interpretation of reliability"* (Krippendorff, 2004, p. 416). The term refers to the *"extent to which independent coders evaluate a characteristic of a message or artefact and reach the same conclusion"* (Lombard et al., 2002, p. 589). This issue was measured using percentage agreement and inter-coder disagreement was taken as an indicator of flawed code drafting and was addressed by redrafting the codes and coding manual for the main study.

Thirdly, and relevant to the main study, which was coded only by the author, are two issues relating to the single coder: bias and stability. Single coder systematic bias (Lombard et al., 2002, p. 591) refers to the effect of the coder's own biases which are amplified if the single coder's predisposition affects the whole data analysis. This was minimised by redefining the codes and improving the coding instructions following the pilot. Single coder stability refers to the degree to which any coder maintains consistency with their own coding decisions across the sample. A test for intra-coder reliability, by repeat coding of ten inventions 24 hours after completion of the main sample, was found to be satisfactory with only a few divergences (Joshi et al., 2011, p.467).

Fourthly, relating to the representativeness of the magazine, or response bias, is the concern that those inventions submitted by the farmer-inventors and then selected by the PFI editor have different characteristics from those not featured in the magazine. This may well be the case, given the paucity of data on farmers' inventions in more developed countries. Interestingly, of

the Irish farmer-inventors who participated in the interviews, only one was aware of and had submitted ideas to PFI. For this reason the parameters of the content analysis population are clearly defined as the stories of those inventions featured in the magazine in the specified time period.

Finally, a potential limitation relates to the unit of analysis, i.e. one invention as described in PFI. The magazine regularly features more than one invention from a single farmer-inventor and information relating to two variables (farm enterprise and location) is generally not provided in all the individual stories. This means cross-referencing between the units of analysis within the magazine in order to obtain the relevant information. This could be said to violate the independence of the unit of analysis, however this is not considered to undermine the validity of the study as the magazine issue is the observational unit. To conclude this discussion of limitations and because “*validity presumes reliability*” (Bryman, 2012, p. 173), I have shown that this single coder study has produced, as far as possible, consistent and reproducible data, with the added safeguard of intra-coder reliability testing on completion. The pilot study gives further gives confidence to the code design and the findings from the content analysis are presented at Chapter 4.

3.5 Stage 3 – Semi-structured Interviews with Key Informants

3.5.1 Why Key Informants?

The aims of the five (including one pilot) semi-structured interviews with key informants from formal organisations in the Agricultural Knowledge and Innovation System (AKIS) was to explore the institutional landscape of user innovation in Ireland and to offer insights that might assist in the case selection for the farmer-inventors' interviews. Additionally, following the findings of the content analysis wherein only 4 per cent of the total inventions analysed were from Irish farmers, these interviews sought views as to relevance of those inventions to the Irish context.

Originating in ethnographic studies, a key informant (KI) is an “*expert source of information*” (Marshall, 1996a, p. 92, writing on health care research) within “*a certain cultural domain*”

(Tongco, 2007, writing on ethnobotany, p. 153). KIs may act as gatekeepers in the field (Bryman, 2012, p. 439) but the focus for this study was their specialist expertise arising from their particular role in the Agricultural Knowledge and Innovation System (AKIS), to be accessed through a solicited interview (Bryman, 2012, p. 440). The use of KIs allows for efficiency and productivity from a limited set of informants; necessarily limited, and with the attendant risk of bias acknowledged, as the number of prospective experts is small (Tongco, 2007, p. 153). Significant insights, which may not be known to all the members of a community, can be gathered in a short period of time due to:

“their personal skills, or position within a society, [KIs] are able to provide more information and a deeper insight into what is going on around them... They are interested in the behaviour of those around them, they observe the development of their culture and often speculate, or make inferences about, both” (Marshall, 1996a, p. 92).

KIs are usually of high social status and *“usually, but not invariably, occupy a position of responsibility and influence. This status should have been achieved, rather than ascribed to the individual”* (Marshall, 1996a, p. 92), while the participatory research literature acknowledges that those of lower social status will have valuable contributions to make based on their proximity to the problem and their lay knowledge and experience (Hall et al., 2006, p.20). While their role in the community might grant them KI status (Tremblay, 1989, paraphrased in Marshall 1996a, p. 92) participants’ knowledge, willingness, communicability, and impartiality can only be assessed in interview; Tongco (2007, p. 154) describes these qualities as *“reliability and competence”*.

The literature suggests there are drawbacks to the use of KIs relating to three main areas: the informant, the relationship between researcher and informant, and the data. The informant may not be knowledgeable but seeks to improve their status in the community through the informant role (Marshall, 1996a, p. 94), while the researcher may become overly reliant on the informant’s knowledge and opinions (Bryman, 2012, p. 440). Differences in status between the informants

and researcher may affect their relationship and, by implication, the quality of data collected (Marshall, 1996a, p. 93). The informant may also have hidden biases or agendas (Tongco, 2007, p. 154), or offer information deemed by them to be more acceptable to the researcher (Marshall, 1996a, p. 93), including the risk of unsolicited “*staged*” events (Bryman, 2012, p. 440). The data may not be representative of the wider community (Marshall, 1996a, p. 93) and generally KIs are said to be more reliable regarding objective than subjective topics (Tongco, 2007, p. 154). It was recognised here that the key informants’ contexts, for example the framing of agricultural innovation in the AKIS organisations they represented, their formal training and education, and experience of farmers and farming, would influence the interview data, in a similar way as was identified for the magazine data.

These potential difficulties were managed through the research design. Informant selection was determined by their role (in user innovation in Irish agriculture or the Irish AKIS) and contextual knowledge (based on in-depth exposure to farmers and/or their inventions over years). Selection was discussed with supervisors and other contacts with experience of the Irish AKIS. The interactions with KIs were ethical and appropriate at all times and the relationship was written up as part of the researcher’s field notes or “*debrief*” (Wengraf, 2001, p. 142). In keeping with the multi-perspective research design, data emerging from these interviews was considered alongside the content analysis data while setting up the Stage 4 interviews.

3.5.2 Selection of Key Informants

One aim of this study is to understand the organisational context of Irish agriculture, so the sample was selected purposively, i.e. the researcher “*actively selects the most productive sample to answer the research question*” (Marshall, 1996b, p. 523). This strategic approach to KI selection contrasts with methods which are deemed “*neither productive nor efficient*” (Marshall, 1996b, p. 524), e.g. convenience sampling (involving chance informants) and the quantitative method, whereby a representative sample is required in order to claim generalisability for the results. The use of key informants is consistent with the more participatory agricultural

literature, as suggested above. Spielman et al. (2011, p. 200), studying smallholder innovation network in Ethiopia, recognised key informants as “*development agents, cooperative managers, ... [local] officials, and leaders of community based organizations*”, while Stringer and Reed (2007, p. 105), in a participatory study of land degradation in Southern Africa, used key community informants including farmers, to identify areas of ecological degradation and to advise on sampling site selection.

Based on Prager and Thomson’s analysis of the Irish AKIS (2014, p. 7) there are a number of public and private sector organisations that may have an interest in farmers’ inventing. Private sector organisations relevant to these interviews were found to overlap with public sector and farming-based organisations to a certain extent. For example Enterprise Ireland (public sector) provides advice and funding to businesses, albeit those targeted at exports, while local LEADER groups (NGO) work closely with agricultural businesses (private sector), such as co-operatives, in their areas. The relationship between public sector and commercial R&D is increasingly one of partnership rather than competition. The KIs were therefore selected according to their involvement in running invention competitions or through their close contact with farmers, in their roles as farm advisers, built up over years (see table 3.4).

Level, organisation type	Role	Number of participants
Local/county - farming based organisation and Non-Governmental Organisation	Involved in organisation of county invention competition, provides business advice	1
National – public sector	Involved in organisation of national innovation competition, provides business advice	2
National – public sector	Provide advice to farmer clients	2

Table 3.4: Key informant profiles: level, organisation type, role, number of participants in the role (Source: Self)

In carrying out the interviews, it was important to encourage the respondent to identify the issues they considered most pertinent, for them to understand the researcher's expectations,

and to feel able to answer the questions. Photographs of farmers' inventions from PFI magazine were shown to the KIs towards the end of the interviews to encourage discussion of Irish farmers' inventions. When wrapping up the interview, I made sure that all the topics had been covered as completely as possible, clarification sought for any contradictions in the informant's responses, and that the KI had said everything they want to say (adapted from Laforest et al., 2009, p. 4). A copy of the key informant interview guide, which sets out the main questions, is attached at Appendix 3.

The use of semi-structured and in depth narrative (see section following) interviews fits well with the research question, which views knowledge and innovation as socially constructed and situated, and focuses on individual farmer's processes and subjectivities. Bryman (2012, p. 470) finds that less structured interviews allow the participant's point of view to come across with depth and detail, which might not be captured in a survey or structured interview. The approach also allows participants the space to express themselves in their own words and to put forward insights that may not occur to the researcher to include in a structured questionnaire, including talking about their feelings, which may not be forthcoming in a group interview setting. Copies of the project information leaflets and consent forms given to interview participants are attached at Appendices 4 and 5 respectively.

3.6 Stage 4 - Narrative Interviews with Farmer-inventors

3.6.1 The Biographic-Narrative Interpretive Method

Rooted in psychoanalysis, the Biographic-Narrative Interpretive Method (BNIM) is a qualitative interview and analysis method used to exploring personal histories, lived situations, and experiences (Wengraf, 2001, p. 232). The BNIM approach has been used to explore *"the peculiar embeddedness of farmers in family farm and farming community settings and the strong influences of past as well as present, and collective as well as individual forms of knowledge and wisdom on farmers' decisions"* (McDonald et al., 2014, p. 24). It can be said to provide subjective accounts that go beyond reflection on past practice to a detailed account of actions required to

achieve future outcomes. The BNIM method also complements and builds upon the earlier stages of data collection, i.e. the content analysis and semi-structured interviews, to provide multiple perspectives on farmer-inventors' motivators.

This qualitative method was chosen because of its *“orientation to the exploration of life histories, lived situations and personal meanings in their socio-historical context”* (Roseneil, 2012, p. 2), and its attention to the complexity and specificity of lived experience. I am interested in the social and cultural factors affecting farmers' inventing behaviour so this kind of narrative interview was found to be particularly suitable for farming participants, *“given the nature of farming as an occupation that is strongly influenced by wider members and previous generations of the farm family”* (McDonald et al., 2014, p. 24). One important use of biographical methods is said to be *“reconnecting social policy with lived experience”* (Chamberlayne, 2005, p. 5). Farming practices are highly policy driven and regulated and I am interested in farmers' interactions with formal organisations involved in innovation support. The interview data in this regard was analysed through the frame of the Agricultural Knowledge and Innovation System model.

The practical aim of BNIM is to encourage interview participants to describe in detail the important factors influencing, in this case, their inventing activities, motivators, and decisions, from their own perspective. The unstructured nature of the interview means that farmer-inventors' *“subjective perceptions, viewpoints, opinions, knowledge types etc. and their life histories”* (Macken-Walsh et al., 2012, p. 5) are encouraged to be expressed in a way that is not limited by the researcher. In this way the researcher reduces as much as possible their influence or bias on the farmers' narratives and uncovers their *“dated situated subjectivity”* (Wengraf with Chamberlayne, 2013, p. 64). This contrasts with a structured or semi-structured interview, where questions and answers are guided and the latitude for the participant to respond may be limited.

The BNIM method involves up to three interview subsessions. In the first subsession, one single question is asked. Known as the SQUIN (Single QUestion aimed at Inducing Narrative), it is a scripted standard question. For this project the SQUIN was:

“As you know I am researching how farmers invent things for themselves. So, can you please tell me the story of your inventions from when you first started doing it to the present day? All those events and experiences that were important for you, personally. I’ll listen, I won’t interrupt. I’ll just take some notes in case I have any questions for after you’ve finished. Please take your time... Please begin wherever you like...”

The researcher facilitates rather than steers the interview for as long as the participant wishes to talk and upon whichever aspect of their story. The researcher notes key cue phrases that will be used, in order of telling, in the second sub-session (which follows the first after a break of a few minutes). The researcher uses the cue phrase to ask for more of the narrative of a particular event or experience as it happened, known as a PIN (Particular Incident Narrative). A third sub-session is optional and occurs after the researcher has analysed the transcripts and field notes from the earlier sub-sessions, and only if there are outstanding questions relating to the research topic. This usually takes the form of a semi-structured interview.

In the event, the interviews with farmer-inventors ranged in length from one hour to five hours face-to-face, with only one third sub-session required. In addition, some of the participants showed me their inventions and personal archives, including photos, videos, newspaper cuttings, trophies, as well as showing me taking me around their workshops and yards. This resulted in much rich data.

3.6.2 Selecting the Farmer-inventors

Given the small number of participants ($n = 5$), the approach to participant selection was similar to that used in choosing case study participants. This means that the participants were not written up or analysed as case studies, but that such an approach was useful for this part of the study that used in-depth narrative interviews and field visits. The individual unit of study was

defined as a single Irish farmer-inventor. The defined temporal and contextual bounds of the research setting is rural Ireland in 2015, and the focus on a small group of farmer-inventors enables rich and deep analysis (Flyvbjerg, 2011, p. 301). I wanted to allow better understanding of existing theory, i.e. the social and cultural factors affecting user innovation, and to exemplify a particular idea, i.e. how farmers' inventions manifest in a more developed country. The use of narrative interviews met the needs of the research problem.

We have seen that the process of invention involves investment and conversion of capitals, including the acquisition and sharing of knowledge and skills in social learning communities. It was decided, therefore, that the selection criteria for the interviews be based on the farmer-inventors' level of engagement with learning communities. As stated in Chapter 1, my definition of a farmer-inventor is a farmer who takes their invention into the public domain, i.e. beyond the farm gate, so this criteria was a visible and recognisable aspect of their practice. In this way, the criteria reflected the theoretical framework and provided a practical means of assessing which individuals to approach. It also meant that factors such as age, gender, or farm enterprise did not form part of the selection criteria.

The interview participants were the farmer-inventors of tangible technological artefacts and, although most farmers are believed to invent, there is no claim that these farmers were representative of farmer-inventors in Ireland or elsewhere. Using the language of 'sampling' or 'variables' when selecting participants is thought to be unhelpful as this can cause confusion with statistical generalisations to populations, which is a different, albeit sometimes complementary, approach (Yin, 2014, p. 21). All the farmer-inventors were from farming families, male, and the dataset includes a father and son who farm and invent together. All are born in Ireland, except one; he is from Germany and has farmed in Ireland for over thirty years. Five in-depth interviews, including a pilot, were carried out at the different levels of engagement - local, national, and global:

- Participant 1 (Pilot) – local and national engagement; evidenced by multiple entries to invention competitions;
- Participant 2 – global engagement; evidenced by sharing of inventions through PFI magazine;
- Participants 3 and 4 – local and national engagement; evidenced by entry to county and national invention competitions;
- Participant 5 – local engagement only; evidenced by information from his son, a fellow PhD student, that he does not enter competitions, but shares his ideas locally.

These individuals were identified through my own networks, Teagasc advisers, and by meeting them at agricultural shows, where they were taking part in invention competitions. Apart from their engagement with social learning groups, all had their own capital conversion strategies and relationships with formal organisations in the AKIS.

3.7 Stages 5 and 6 - Interview Data Analysis and Participatory Data Testing

Both sets of interviews were recorded for transcription and then analysed thematically. Copies of the transcripts were sent to the participants for comments and final approval. No substantive comments were received, other than some relating to the type of vernacular the participant used, and no transcripts were withdrawn. For the purposes of writing up the analysis, and to reflect the biographical nature of the interviews, it was appropriate to give the farmer-inventors a pseudonym when directly quoting or referring to them, rather than using codes (see Table 3.5). The key informants are from formal organisations in the Agricultural Knowledge and Innovation System (AKIS) and comprise two women and three men involved in encouraging or diffusing farming innovations; three have been involved in the organisation of invention competitions. For simplicity, they are identified by codes, KI 1-5.

<i>Farmer-inventor code</i>	<i>Pseudonym</i>		<i>Key informant</i>	<i>Code</i>
F1	Francis		1	KI 1
F2	Mark		2	KI 2
F3	Declan		3	KI 3
F4	Alan		4	KI 4
F 5	Kevin		5	KI 5

Table 3.5: Farmer-inventor Pseudonyms and Key Informant Identity Codes (Source: Self)

Silverman (2000, pp. 122-125) sets out two approaches to the analysis of interview data. First, the realist approach that assumes interview answers describe an “*external reality...or internal experience*” (p. 122), which are presented as facts to the reader. Second, the narrative approach, which as he describes it, finds interview answers tell a story that expresses the participant’s perception of the world, which is socially and culturally constructed, and that can challenge stereotypes (p. 125). The emphasis in this approach is on producing a “*narrated reality in which ‘situated’, or locally produced, nature of accounts is to the fore*” (p. 123) along with the multiple meanings that arise from an “*actively constructed*” narrative (p. 123). The narrative approach is very much in line with my theoretical framework and the research focus on knowledge generation and invention. An investigation of the process of narrative construction was outside the scope of this study.

Thematic analysis is claimed to be widely used, yet Bryman (2012, p. 578) finds that it has no clear provenance or agreed approach. It does however allow an evolution from the quantitative structures used in the earlier data collection stage of this project towards developing a “*coherent, thick description*” (Holliday, 2002, p. 77) that reveals the “*different and complex facets of particular phenomena*” (p. 107), which will be particularly relevant in the investigation of farmers’ conceptualisations of knowledge and invention. In developing the themes and sub themes for the data analysis, I drew upon the data itself and the findings of the previous stage of data collection, in order to “*access... [the] subjects’ own categories*” (Silverman, 2000, p. 186) using an inductive approach and then applied my own understanding of the context based on the literature and field experience. Once the themes and sub themes were drawn out from the data, I scrutinised what the participants had said in relation to them and then further analysed

their comments in the context of their inventions, as well as the broader social and political picture, to arrive at my preliminary findings.

I wanted to be as participatory as possible throughout the project, within the constraints of the institutional contexts, and a round of data testing involving the research participants followed the preliminary analysis. In Stage 6, the findings were summarised in a project update document (Appendix 1), using everyday language, that was sent to all interview participants for their comments. I call this stage ‘participatory data testing’ as it invited the participants to contribute to the research more extensively by offering their interpretations of the findings which would influence the final analysis. I had originally planned to bring all the farmer-inventors together to discuss the findings in what Franz (2013, pp. 1-2) calls a “*data party*”, but time and logistics (I was back in England) meant that this was not possible. In the event, those participants who responded to the update (two of the key informants and three of the farmer-inventors) had no substantive comments, were positive about findings overall, and were pleased to have been consulted.

3.8 Validity and Reliability

Turning to issues of data quality, the research question involved both qualitative and quantitative data. While the staged data collection approach allowed for each stage to be informed by the analysis of the previous stage, in order to allow themes to emerge, the execution of data collection and analysis must satisfy the internal requirements of each method, whether qualitative or quantitative. For example, the content analysis is deemed to be rigorous (i.e. valid and reliable) within the terms of the content analysis method and its limitations (see sub-section 3.4.5 above). In the same way, the evaluation of the qualitative stages was no less rigorous.

In regard to qualitative interview data, Silverman (2000, p. 175) defines validity as the “*extent to which an account accurately represents the social phenomena to which it refers*” and highlights that qualitative research is at risk of “*anecdotalism*” (p. 176) if generalisations are made based on data that is selected specifically to support those findings. In designing the project, I

addressed these concerns by selecting interview participants using criteria that were developed to inform the research questions, explaining decisions regarding my choice of samples, and being critical in my analysis of the data.

Reliability is defined by Silverman (2000, p. 175) as the *“degree of consistency with which instances are assigned to the same category by ... the same observer on different occasions”*. As I did the analysis of data myself, I expected to achieve a good level of uniformity of understanding on each reading, allowing the layers of meaning to emerge over time. Being involved directly in the data production also means I was aware of any predetermined interpretations in my mind when approaching the readings to enable me to *“access ... [the] subjects’ own categories”* (Silverman, 2000, p. 186). While the potential for generalisations to be drawn from small in-depth samples in qualitative research is contested, Silverman (2000, p. 110) contends that we *“need not be defensive about the claims of qualitative research”*. The research design approached the body of data inductively, in that it sought to draw *“generalisable inferences”* (Bryman, 2012, p. 26) from the data. The use of both qualitative and quantitative data collection and analysis methods allowed the multiple perspectives discussed above to emerge.

3.9 Ethics

As this research involved human participants, I set out here the approach taken to ethical issues. I received formal approval from the Open University (OU) Human Research Ethics Committee (HREC) (reference number HREC/2013/1522/OFlynn/1) under the University’s ethical code (Open University, nd) prior to starting fieldwork. The OU ethical code has six principles, which are discussed below or as indicated:

- compliance with the project ethics protocol;
- informed consent of participants;
- openness and integrity in researcher behaviour (section 3.9 below);
- protection from harm;
- confidentiality;

- compliance with professional codes of practice and ethics.

I received training on ethics within the OU as part of the doctoral programme and also, specifically on aspects relating to participatory research, at Durham University's Centre for Social Justice and Community Action. In developing the ethics protocol for this project I consulted the guidance published by the British Sociological Association statement of ethical practice (2002) and the Sociological Association of Ireland ethical guidelines (nd).

I set out next how I applied the project ethics protocol in the relevant data collection and analysis stages. First, regarding the content analysis, the inventions were submitted to the magazine by farmers, some of whom did not want their identity revealed. My analysis focused mainly on the features of the inventions, but I did collect data, where available, on some aspects of the farmer-inventors themselves: country of location, type of farm enterprise, did the farmer-inventor bring in outside help, is the farmer seeking commercialisation. Those farmers seeking to commercialise their inventions usually had their contact details published in the magazine, yet it would not be possible to identify a farmer from the content analysis data as the most information available about an individual would be, for example, that they were a dairy farmer from Scotland. Through publication in the magazine the inventions were in the public domain, so issues of Intellectual Property protection did not arise.

Turning to the data collected through interviews, participation was voluntary and informed consent was received from each participant by making them aware in advance of any risks, or indeed benefits, that might affect their willingness to take part in the research. This was done through discussion and by giving the participants written information, in an accessible form, about the project, how their data would be used, confidentiality, and their rights regarding the data. Written project information was in English (see Appendix 4), but was also offered in Irish and alternative formats, i.e. large print, audio.

Prior to providing consent, participants were made aware that the data was being collected solely for the purposes of this research project, would be anonymised (unless otherwise agreed)

and not be passed to other parties. Consent could be withdrawn at any time and participants were able to request that any data they provided be destroyed. Participants provided written consent to the collection and use of their data (see Appendix 5) and were given access to the research outcomes by means of copies of their interview transcripts, as well as a written project update (see Appendix 1). This also provided an opportunity for participants to comment on or clarify their data. This was particularly relevant to the participants in the Biographic-Narrative Interpretive Method (the farmer-inventors), which encourages the participant to describe their lived and emotional experiences, but which, on reflection, they may prefer not to have included in the interview record.

The key informants were interviewed as representatives of their employers using semi-structured interviews which focused on their professional experience and their employers' policies and practices. While the employing organisations might be discussed in the literature review, the key informant's personal identity code is not linked to the employer in any way. None of the participants requested any changes to their interview transcripts, although one key informant asked at the time of the interview for some comments to be off the record.

In order to minimise harm, no children, vulnerable people, or covert methods were involved in this project. Participants were also made aware of issues relating to confidentiality in relation to the Intellectual Property (IP) of their inventions. Collecting information on farmers' inventions might include data that may be claimed as the IP of the participant and the disclosure or sharing of such information might be harmful to the participant's interests. The research questions consider the extent to which farmers share their inventions freely (i.e. give up their intellectual property rights), so this issue was discussed in the interviews. Although information about the inventions might already be in the public domain (e.g. through the magazine or taking part in invention competitions), the project outputs do not describe any invention in any detail sufficient to threaten IP rights. In order to mitigate this risk the project information leaflet and consent form reference this issue for specific consent and supply contact details of supervisors in case of complaint. When giving any presentations on the project, the images I use to depict farmers'

inventions are taken from public sources, i.e. Practical Farm Ideas magazine, and do not depict the participants' inventions.

I also considered whether the multi-perspective approach might introduce ethical issues over and above those that arise when using a single research approach (Creswell et al., 2011, p. 24). One aspect was that the participants were to be contacted on three occasions: the interview, following the supply of the interview transcript, and the project update. This could be overly demanding of their time, particularly for the farmers. The farmer-inventor interviews were carried out and the transcripts supplied in the autumn and winter of 2015, usually the farmers' quieter time of the year. However, the project update was supplied in the summer and one farmer, when contacted, said he would not be able to look at it properly until his summer work was finished.

With regard to the data analysis and storage, data has been kept secure through the following means: individual records were coded as soon as possible after collection to remove non-essential identifying features and the linking code has been kept separately from the dataset; paper records are kept in a locked cabinet and electronic records are password protected and held on secure systems; access to individual records is limited to the student and project supervisors. This research complies with the UK Data Protection Act 1998, the Irish Data Protection Act 1988 (as amended), and the guidance issued by the UK Information Commissioner's Office and the Data Protection Commissioner (Ireland).

Turning to health and safety, a risk assessment showed that the overall likelihood of psychological, physical, social, economic, and legal harm to participants and researcher is low. With regard to risks to the student carrying out interviews and observations in new settings, the initial risk assessment suggested low to medium risks of harm through lone working and in the farm environment. To mitigate the risks relating to lone working the research was carried out in accordance with the Code of Practice for the Safety of Social Researchers produced by the Social Research Association (Social Research Association, nd). Visits to farm environments were in

accordance with guidance issued by Teagasc and Health and Safety Authority of Ireland. I have lived on a farm and am familiar with the cultural environment in rural Ireland. I have worked as an Environmental Health Officer specialising in health and safety at work enforcement and therefore have a well-developed understanding of hazards and risk management. Both the risk assessments relating to participants and myself were kept under review throughout the project and any issues arising were raised as part of the OU six monthly formal review.

In conclusion, enacting the principles of the OU's ethical code in the research design minimised the risk of physical, psychological, or reputational damage, not just for participants and the researcher, but also colleagues, the University, and Teagasc. Maintaining the OU ethical code requirement for openness and integrity in researcher behaviour required a reflexive approach, which is considered next.

3.10 Researcher Reflexivity

I take the position that critical reflection is essential to the ethical carrying out of research activities, in respect of process (research design and execution), content (issues, findings), premise (fundamental assumptions) (Coghlan and Brannick, 2010, p. 12, citing Mezirow, 1991), openness, and integrity in researcher conduct. However, I am realistic that my best efforts at reflexivity may not reveal all my subconscious biases and that, in common with many researchers perhaps, *"it may be impossible to grasp the unconscious filters through which we experience events"* (Mauthner and Doucet, 2003, p. 425).

One aspect of my process reflexivity and development as a researcher is that I lacked skills relating to quantitative research methods before embarking on the first stage of data collection. I therefore deferred my fieldwork for three months while I undertook the relevant modules of the Open University (OU) Masters in Research programme, along with training in SPSS software. I enjoy facilitating group learning and initiated an action research group in the OU and a qualitative research group in Teagasc to share knowledge and experience, in order to reduce what I call 'methodological isolation'.

The staged data collection approach meant that reflection was built in at every stage of the project. Reflexivity is also a means to understand the consequences of the researcher's presence in the field, to *"come to terms with and indeed capitalise on the complexities of their presence within the research setting"* (Holliday, 2002, p. 146). Flyvbjerg asserts that the *"most advanced form of understanding is achieved when researchers place themselves with the context being studied"* (2011, p. 310). A lack of objectivity has been a major criticism of qualitative research and reflexivity has been suggested as a means to understand the consequences of the researcher's presence in the research setting. In this project the research setting included the farmer-inventors' homes and farms, as well as the institutional setting in Teagasc.

Reflexivity, however, does not just mean awareness of the emerging needs of the project and my development as a researcher, it also means that the researcher reflects, willingly and transparently, on their own unconscious biases, possible conflicts of interest, and the impact of the research on participants' lives. Sumner (2008, p. 10), in the international development literature, crystallises it thus: *"The real issue is who speaks (or claims to speak) for whom?"* and in this project I have adopted the approach of researching with the participants, rather than research on people (Oreszczyn et al., 2010, p. 407).

In this study, I am conscious that I was an External Researcher (outsider) by nationality (English) and culture (metropolitan, liberal) with my own values, history, and expectations, which I probably would not have in common with the research participants. My gender (female) and age (early 50s) would also influence my interactions with farmers in what is a male dominated, socially conservative sector (Chiswell and Wheeler, 2016, p. 232). Nor do I have a farming background, although my professional career in the UK involved occasional rural and farming related activities over the years, ranging from working as a meat inspector in an abattoir to developing national policy for managing outbreaks of infectious diseases in farm animals. My formal qualifications and governmental experience grants me status in the knowledge hierarchy compared to that of the farmers' tacit knowledge, yet I do not claim any expertise in farming. This raises the prospect of issues of power between the researcher and participant and, while

the difference in educational attainment between myself and the participants was discussed on occasion in the interview setting, their knowledge and skills in farming were acknowledged also.

Since 2011, I have actively immersed myself in the Irish rural context over extended periods: for a year while doing my Master's degree (2011-2012) and for 18 months while carrying out fieldwork for this study. This enabled me to develop my personal reflexivity and involved living on my cousin's farm in Galway for a year and interacting with the wider family network of farmers and rural dwellers; attending and interacting with farmers at meetings of a UK beef and sheep discussion group; reading the farming media in Ireland and the UK; meeting farmer-inventors at UK and Irish agricultural shows; taking part in the Dublin Beef Hackathon; working on an Irish rural protest campaign for my MA thesis (National University of Ireland, Galway), and, organising an event with Irish farmer-inventors for Culture Night (2015). However, this immersion did not give me much direct experience of farming and when discussing individual inventions I did not venture an opinion, positive or negative, as to its properties. It is for the farmer, as inventor or user, to determine its value in any particular context and for other farmers to critique.

In the Teagasc setting, I was exposed to agricultural theory and practice through research seminars, training, and interaction with colleagues. There, I was simultaneously an insider researcher and an outsider, for the reasons described above. Meeting Teagasc's organisational culture was challenging at times, professionally and personally, and I worked at building relationships with colleagues to help clarify any tensions. In practice, developing reflexivity meant keeping a research journal, checking my understanding of the context using the Johari Window method (Chambers, 2002, p. 111), actively sharing reflections with colleagues and others in my personal network, which includes farmers. In writing this thesis I have tried to ensure that it is free of bias towards any group. Finally, my commitment to participation, action, and ethics underpinned the entire project.

3.11 Conclusion

In this chapter I have set out the methodology and research design for this thesis, including the theoretical framework and justification for the use of a multi-perspective approach to achieve the research aim of contributing to knowledge by investigating farmers' inventing activities and the networks of relationships involved. I also address issues of researcher positionality, ethics, and rigour. In the next three chapters I explore the findings from the analysis of the qualitative and quantitative data collected. In Chapter 4 I use the data from the content analysis to describe some characteristics of British farmers and their inventions. In Chapters 5 and 6 I use interview data to discuss Irish farmers' motivators for invention, their learning communities and interactions with the formal organisations in the AKIS.

Chapter 4 – Characteristics of Farmers’ Inventions

4.1 Introduction

In this chapter, I present the results of the content analysis of the stories of inventions featured in Practical Farm Ideas magazine (PFI) (n = 210). The data relates predominantly to inventions of British (English, Welsh, Scottish) farmers (74 per cent), with other countries (including Northern Ireland and the Republic of Ireland) at 8 per cent. No location was identified for the remainder of the farmers (18 per cent) and, although some of these may be from other locations, it is assumed for the purpose of this analysis that they are from British farmers, making a total of 92 per cent overall.

The analysis covers the described characteristics of the inventions, as well as limited demographic information on the farmer-inventors. I do not seek in this chapter to make inferences as to British farmers’ economic, social, and cultural motivators for invention, which are discussed in relation to Irish farmers in the following chapters. The insights here contribute to the overall multi-faceted analysis of this thesis and allow a comparison of certain aspects of British and Irish farmers’ inventing in Chapter 7.

The stories of inventions are found in two issues each of PFI from the years 2003 (29 per cent of the sample), 2008 (40 per cent), and 2013 (31 per cent). Changes in the data over time are considered retrospectively in order to identify any tendencies in the data, although limitations in the data mean that no claims for prediction are made: the results are descriptive. I apply the frame of, first, economic thinking to the stories of inventions which suggests that inventors will seek economic benefits from their inventions, both in use and through commercialisation (Henkel and von Hippel, 2003, p. 4), and, second, user innovation literature which finds inventors share their inventions freely with others in their user community (Flowers et al., 2010, p. 16). These apparently opposing positions are explored here to the extent possible in a descriptive analysis and are discussed in greater depth in relation to Irish farmers’ inventing behaviour in Chapters 5 and 6. Next, I apply a characterisation of inventions from the design literature that

looks at the effect of the invention, in terms of technological development, as well as the form that it takes. I also describe some of the inventions that feature in the sample to illustrate the various characteristics under discussion.

First, I present the results for research sub-question 1 (RSQ1), 'Who are the farmer-inventors?' as it relates to the farm enterprise in which the invention arose and the farmer-inventor's location. I find that, although over two fifths of the stories sampled are from tillage farmers and agricultural contractors, and almost half from English farmers, nearly a fifth of the cases do not have either of these characteristics identified.

Second, I present the results relating to research sub-question 2 (RSQ2), 'How do farmers approach the invention process?' i.e. the progression from creation to use, as it relates to the activity to which the invention relates and the benefits claimed for invention in use. I also look at the relationship between farm enterprise and activity. I find evidence in the stories to support the idea that farmers' inventions are livelihood related and bring mainly economic benefits in use. I then consider the extent to which farmer-inventors create inventions from within their existing knowledge and skills, as well as the form and the effect, i.e. the novelty, of the invention as a design improvement (RSQ2). The stories suggest that farmers generally work on their inventions alone, using their tacit knowledge, and that hardly any inventions use Information and Communication Technology (ICT). The inventions featured in the stories sampled here are almost all tangible artefacts, rather than processes. In terms of the effect, the inventions are almost equally split between those which improve an existing technology and those which bring together existing materials for a new purpose. No breakthrough inventions were found.

Third, I present the results relating for research sub-question 5 (RSQ5) 'To what extent do the ties between farmer-inventors and their informal networks represent a social learning community?', as it relates to the free sharing of the invention in the magazine. I find that almost all farmers are not seeking to exploit their invention commercially through the magazine, although they may be using other means to introduce their invention to the market. Section 4.11

summarises how the findings from this first stage of data collection inform the scoping and execution of the subsequent stages of data collection and concludes with a discussion of the findings.

4.2 Data Collection, Analysis, and Presentation

In this section I briefly describe the overall approach to the data collection and analysis and the structure of the chapter. The content analysis considers individual stories of inventions as the unit of analysis, using variables derived from the literature review and emerging from the data itself. The magazine has been in existence for over 20 years and it is worth discussing here how its editorial policy and approach to the collection of invention stories has implications for the sample.

Farmers submit their inventions for publication and the editor, the main writer for the magazine, will often visit the farm and gather an account of the invention directly from the farmer-inventor, as well as photographic images or drawings of the invention (Donovan, 2014). Where a farm is too far away the editor speaks to or corresponds with the farmer-inventor. This means that the story of the invention is based on the farmer-inventor's version of events as reinterpreted by the editor for publication. Those farms within reasonable distance of the magazine's base in Wales, i.e. England and Wales, are more likely to be visited. The editor's approach is to visit a number of farmer-inventors in an area and to publish the inventions as soon as possible afterwards (Donovan, 2014). While this means that the inventions will be current, it also means that an issue of the magazine will often feature inventions from the area most recently visited. Hence, England was the most frequent location of published stories in 2003 at 66 per cent, while Scotland topped 2013 at 40 per cent, after the editor visited the Orkney Islands.

When interviewing the farmer-inventor, the editor is sometimes asked not to reveal their identity, for example by publishing their name, location, or photo. He suggests this is because the farmer-inventor fears a negative response from other farmers in the locality (Donovan, 2014). This raises the possibility of inventing behaviour being seen as culturally inappropriate in

some contexts. This means that a significant proportion of the stories analysed do not have location or enterprise data.

The editor has a degree in agricultural economics and experience as a financial journalist and dairy farmer. He presents an economic perspective on the inventions, emphasising cost and labour savings, yet some of the published stories also mention the farmer-inventor's knowledge and skills. Overall, the sample reflects the editor's distinctive approach to story collection and I do not claim that the magazine is representative of all farmers' inventions. Nonetheless the magazine is a unique data source and the content analysis provides me with important knowledge as to the nature of British farmers' inventions, which I use to inform the interview questions in Stages 3 and 4 in the Irish context. It also allows the researcher to discuss the nature and type of farmers' inventions, thereby building rapport with interview participants and others and to aid dissemination of the project more widely.

Turning to the data presented below, this content analysis is a quantitative method in a qualitatively-led research strategy (Mason, 2006, p. 22) and the descriptive statistics produce measures of frequency, rather than causal or predictive signifiers. I also use bivariate analysis to explore particular relationships, not causality, between certain variables, which adds a layer of additional meaning to the analysis. The data are presented here as bar charts or pie charts and the full list of variables and codes can be found at Appendix 2. In organising the findings of the content analysis below, I first describe the variable, followed by the statistical findings and then a short discussion. Data reduction means that I generally focus on the top three findings for each variable. Please note that, unless otherwise indicated, all percentage figures are rounded up or down to nearest whole figure; .5 per cent values are rounded up. I now turn to a short overview of the farmers' inventions that feature in the sample.

4.3 What do British farmers invent?

Before we turn to the findings of the content analysis, it is worth providing an overview of the variety of inventions featured in the magazine. This section supplements the analysis below as it

relates to the farming activity to which the invention relates, whether it is an artefact or process, and whether the invention uses Information and Communication Technology. Here examples of inventions are grouped according to whether they are mechanical (i.e. with moving parts) or non-mechanical, and either static or mobile.

A fundamental piece of farm equipment is the tractor and many of the British farmers' inventions described in the stories are tractor related. Some are mechanical implements attached to the front or back of the tractor, drawing power from the engine using the power take off (PTO) shaft and involve hydraulics. Some of these mechanical devices are mobile and used in the field, e.g. cultivators, mowers, post drivers, and trailers, or in the yard, such as bale handlers and grain pushers. Others are static in use, such as log splitters and animal lifters. Non-mechanical tractor related inventions include adaptations to tractor cab layouts, tool storage, tractor weights, and safety rails. An invention that occurred more than once in the sample is related to the steps up to the tractor cab, which are usually made of open bars to allow muck from the farmer's boots to be scraped off before they enter the cab. Many British (and Irish) farmers transport their dogs with them in the cab and open steps present a trapping hazard as the dog's leg is small enough to slip between the bars. A farm dog with a broken leg may have to be put down and a number of farmers have designed grids that fit over the steps to prevent such accidents. This also suggests cultural influences on farmers' inventing relating to the farmer's attachment to the animal.

Livestock related inventions are also mechanical and non-mechanical, with some transportable to field locations. As an example, the magazine features stories about a variety of mechanical and non-mechanical cow back scratchers. Non-mechanical devices include static brushes and means to apply topical lice treatment. Mechanical back scratchers have moving brushes activated by infrared switches. Other livestock related inventions include mechanical calf feeders that mix, heat, and pump milk, while non-mechanical static inventions often relate to animal housing, such as feeders and cow cubicles, or animal handling, e.g. crushes.

Inventions relating to the farm buildings and infrastructure include electric fencing systems, slurry pit drains and safety structures, and pest proofing. Unsurprisingly, a number of workshop related inventions appear in the magazine, including storage solutions, a turner to allow access to the underneath of farm implements, and sheet metal benders. There are also stories of process innovations in the sample, including: keeping lame cows in a field near to the milking parlour so they only have to walk a short distance and can be easily monitored; using rape straw as an alternative bedding material; putting coloured tape on the tails of cows requiring special diets. These stories demonstrate not only the creativity and diversity of farmers' inventions to meet a range of farming needs, but their farming, mechanical, electrical, materials and workshop knowledge and skills. It is also suggested that, as seen in the case of the dog-friendly tractor steps, there are values-based and cultural influences on their inventing. As British and Irish farmers share the same regulatory and market environment, in Chapter 7 I offer a multi-perspective view of their inventions. Next, I present the findings of the content analysis.

4.4 In Which Type of Farm Enterprise did the Invention Arise?

Farmers may operate more than one enterprise and it may be possible for an invention to be used in more than one type of farm enterprise (see section 4.6 below). For clarity, in this section I report the findings on the enterprise in which the invention was made (this variable was previously referred to as 'the farm sector in which the invention arose'). The codes under this variable arise from two sources: the literature and the data itself. The European Commission (2014, p. 5) identifies agricultural markets for different products, e.g. cereals, beef, milk, while advice and support in the UK (through the Agricultural and Horticultural Development Board) and Ireland (through Teagasc) are similarly organised. Additionally, in the course of analysing the data another source of inventions arose: contractors. These are usually farmers who are involved in agricultural sub-contracting and whose clients may operate a variety of enterprises. Although not enterprise specific, it is a form of diversified farming enterprise and a code was added to ensure that the findings accurately reflect the milieu in which farming inventions arise.

This demographic information indicates the extent of invention activity across the different enterprises and provides evidence to support whether or not an enterprise based approach to the farmer-inventor interview selection is appropriate. Figure 4.1 shows the overall results for all the types of enterprises reporting inventions, while Table 4.1 presents the findings for the top three types, by year and all years combined. The single invention in the 'Other' category was from a game enterprise, while the 'forestry' and 'other livestock' categories do not appear in Figure 4.1 as they had no inventions in this sample.

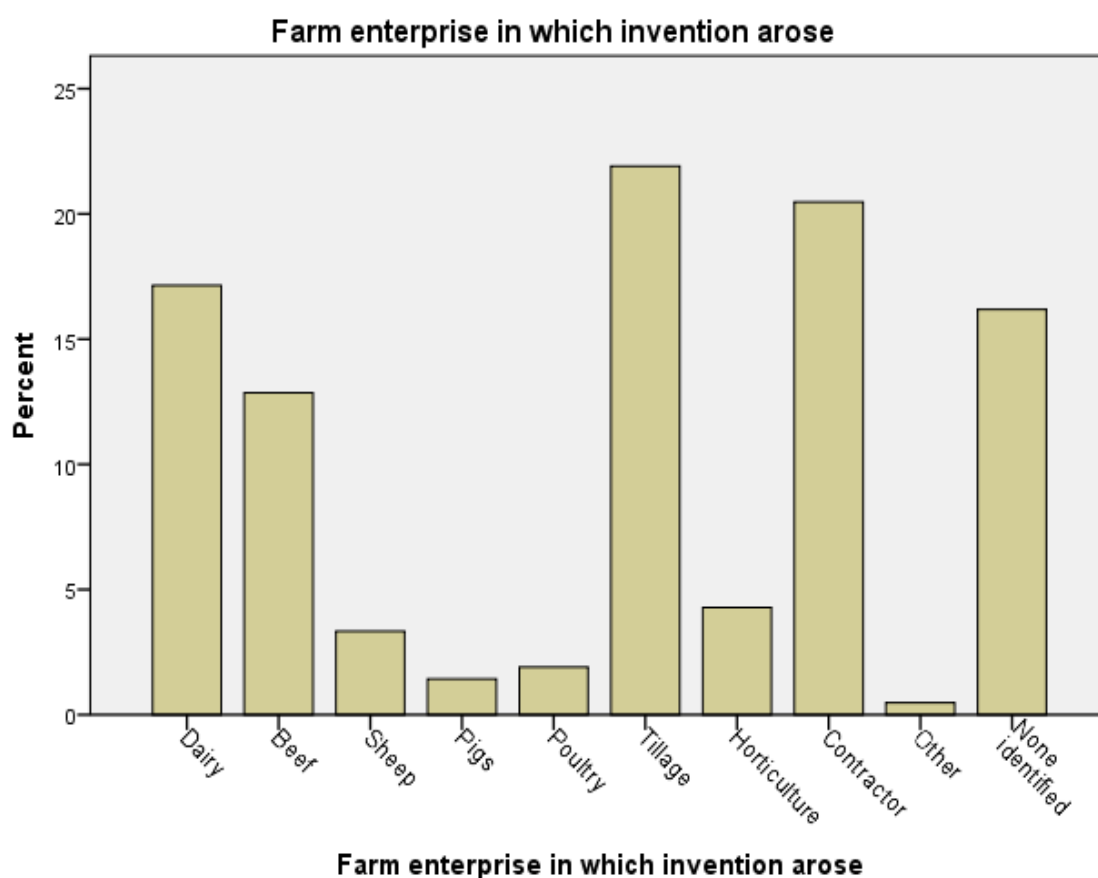


Figure 4.1: Farm enterprise in which the invention arose, all years combined (Source: Self)

There are 12 codes for farm enterprises and the four most frequent overall, i.e. when the three years' worth of data are combined, were: tillage at 22 per cent; contractors with 21 per cent; dairy at 17 per cent. No originating enterprise was identified for 16 per cent of the inventions overall, as discussed above. In Table 4.1, I report that, although the order of frequency in a year is not consistent, only five codes appear in the top three across the three years analysed.

Notwithstanding the large number of inventions with no type of enterprise identified, the four most frequent farm enterprises are found to generate significantly more inventions than any other, with contractors the only type of enterprise to appear in the top three every year. Contractors represent a significant source of inventions, which is consistent with the increasing sub-contracting of tasks to specialists in contemporary farming (Bonanno and Constance, 2001, p. 8). I now consider if location is a factor in farmers' inventing.

By year	2003	2008	2013	All years combined
Enterprise	1. Tillage 2. Dairy 3. Contractor	1. None identified 2. Tillage 3. Contractor	1. Contractor 2. Beef 3. Dairy	1. Tillage 2. Contractor 3. Dairy

Table 4.1: Top three farm enterprises in which invention arose, by year and all years combined (Source: Self)

4.5 Where are the Farmer-inventors located?

In this section I report the findings as to the location of the farmer-inventors who submit their stories to the magazine, which itself is based in Wales. The location demography variable includes the countries of the United Kingdom, the Republic of Ireland, as well as others that merged as the sample was analysed (see Figure 4.2).

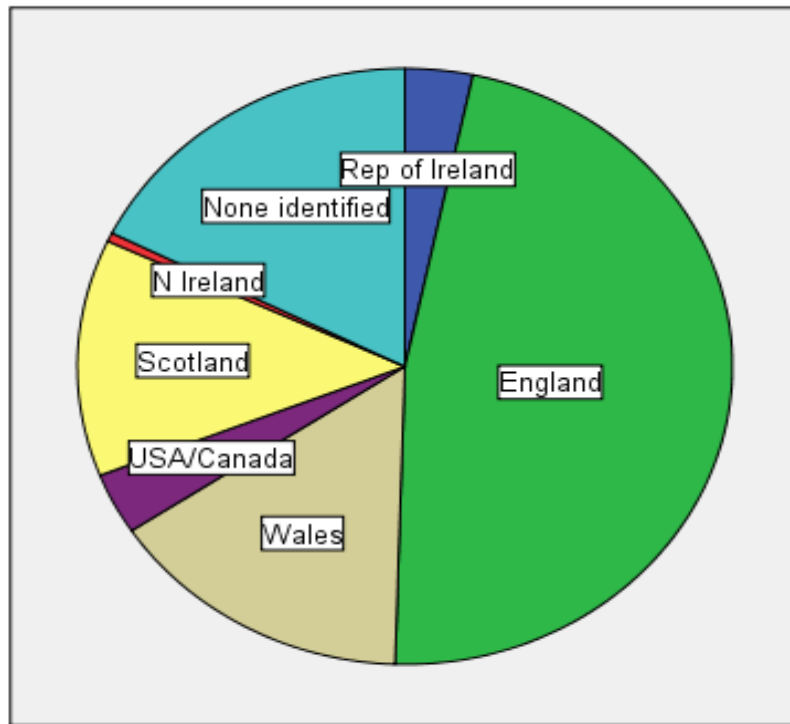


Figure 4.2: The farmer-inventor's location, all years combined (Source: Self)

Overall, England was the top location at 47 per cent, yet 18 per cent of inventions have no location identified, third was Wales at 15 per cent (see Table 4.2). Given the editor's approach to collecting stories and that nearly a fifth of inventions had no identified location, it is difficult to draw any conclusions about the significance of the location of farmer-inventors in this regard. Overall, 4 per cent of the inventions were from Ireland and none of the stories relate to inventions submitted by the one Irish interview participant who has featured in the magazine.

Notwithstanding that the farmer-inventor's location might not appear in the story, the editor's approach to collecting and publishing inventions as he travels raises the prospect of groups of farmer-inventors in an area. These may be local innovation clusters or learning communities (Wenger, 1998, p. 123) involving the sharing of knowledge and ideas between farmer-inventors. The findings relating to Irish farmers' learning communities will be explored in Chapters 5 and 6.

By year	2003	2008	2013	All years combined
Location	1. England 2. Wales 3. Republic of Ireland	1. England 2. None identified 3. Wales	1. Scotland 2. England 3. Wales	1. England 2. None identified 3. Wales

Table 4.2: The farmer-inventor's location, by year and all years combined (Source: Self)

It is not clear from the sample if location is an influence on farmers' inventing behaviour, although local learning communities may be a factor, with inventions found across the different types of farm enterprises. I now look at the extent to which farmers' inventions are related to their farming work.

4.6 Farmers' Inventions are Mainly Livelihood Related

As noted in Chapter 2, the literature implies that user-innovators invent mainly in relation to hobbies, yet work-related user innovations are also found (Shah and Tripsas, 2007, p. 133). In this section, I present the findings about the farming activity to which the invention relates (see Figure 4.3); descriptions of the ten codes relating to the activity variable are set out in Appendix 2. I also present a cross-tabulation analysis of the activities by farm enterprise.

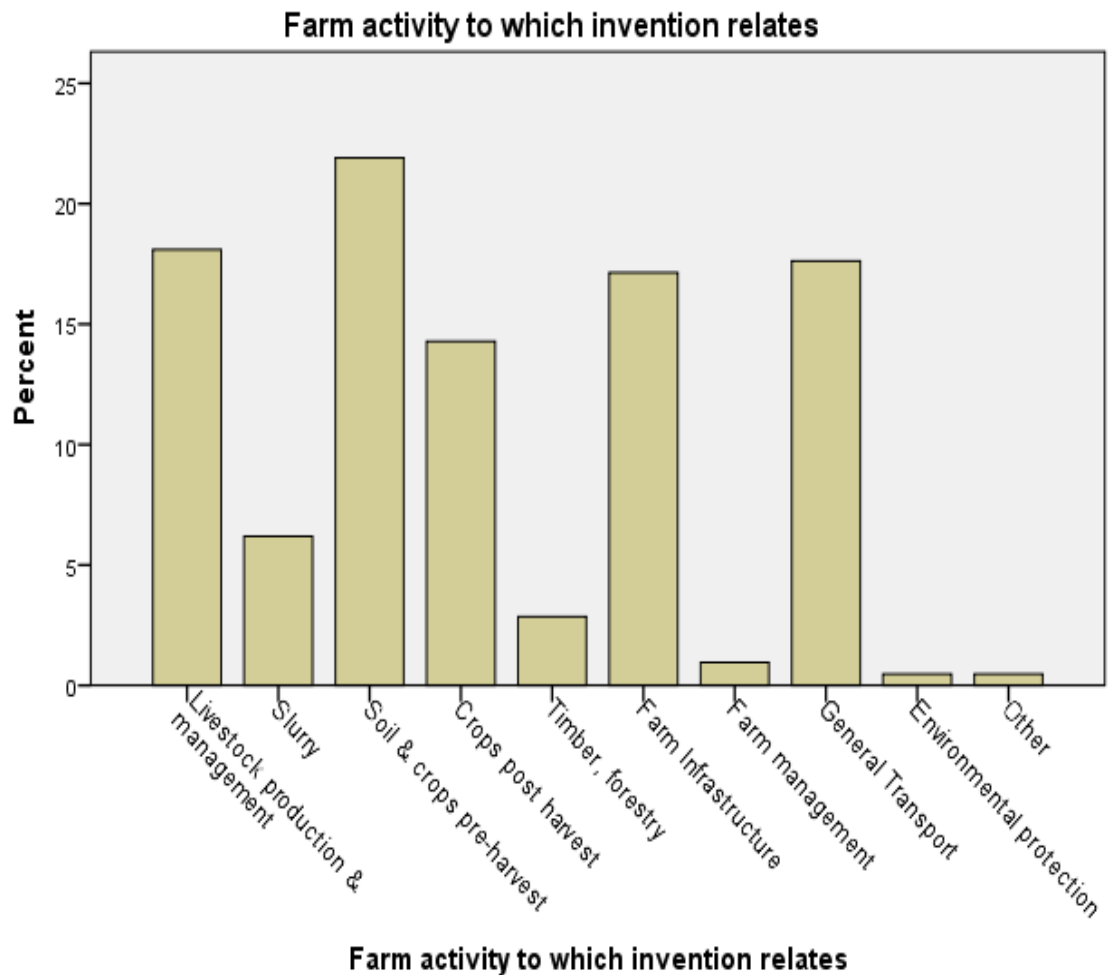


Figure 4.3: Farming activity to which the invention relates, all years, percent (Source: Self)

Figure 4.3 presents the results for the full range of farming activities which generated inventions over the three years of data. Overall, soil and crops pre-harvest inventions, at 22 per cent, occurred most frequently, with livestock production and management and general transport jointly second at 18 per cent, with farm infrastructure third at 17 per cent. Milking and waste management are absent from the chart as there were no inventions related to these activities in the sample, although issues of the magazine from different years did feature such inventions. The single case of non-livelihood activity, the 'Other' code, is a domestic invention although the farming focus of the magazine may mean that such ideas are not often submitted. Table 4.3 presents the findings for the top three activities by year and all years combined. Only five activities featured in the top three across the years studied, with soil and crops consistently the

most frequent; crops post-harvest featured in third place in 2008 and 2013, suggesting that these activities are the main focus of the featured farmers' inventing.

As an example of a soil and crops pre-harvest invention (Practical Farm Ideas, 2008, 17/1, p.21), the story describes a farm-made one-pass cultivator, designed to suit the farm's soil type, which prepares the seedbed for drilling. It comprises four sections: a levelling board to break down the furrow, spring tines to break up the topsoil, Dutch harrow tines for deeper soil distribution, and a crumbler roller to break up any remaining clods. Towed behind the tractor, it is claimed to save time, by combining tasks, and to reduce costs, through straightforward maintenance and cheaper spare parts.

By year	2003	2008	2013	All years combined
Activity	1. Soil & crops 2.Livestock production & management 3.General Transport	1. Soil & crops = 1.General Transport 3.Farm Infrastructure	1. Soil & crops = 1.Farm Infrastructure 3.Livestock production & management	1. Soil & crops 2.Livestock production & management = 2.General transport

Table 4.3: Top three farming activities: by year and all years combined (Source: Self)

Figure 4.4 presents the results of a cross-tabulation by farming activity and the top five farm enterprises. While it shows some predictable differences between livestock and tillage farmers, most of the activities are shown not to be exclusive to one type of farm enterprise with, for example, 11 per cent of post-harvest inventions arising in beef enterprises, often in connection with silage making. These findings influenced my approach to the selection of Irish farmer-inventors for interview, rather than focusing on a particular type of farm enterprise, as was originally envisaged, a non- enterprise based approach was taken. Looking at the content analysis data, I find evidence to support the notion that farmers' inventions relate to their livelihood,

across a range of farming activities, suggesting that the inventions might provide some kind of economic benefit to the farmer-inventor.

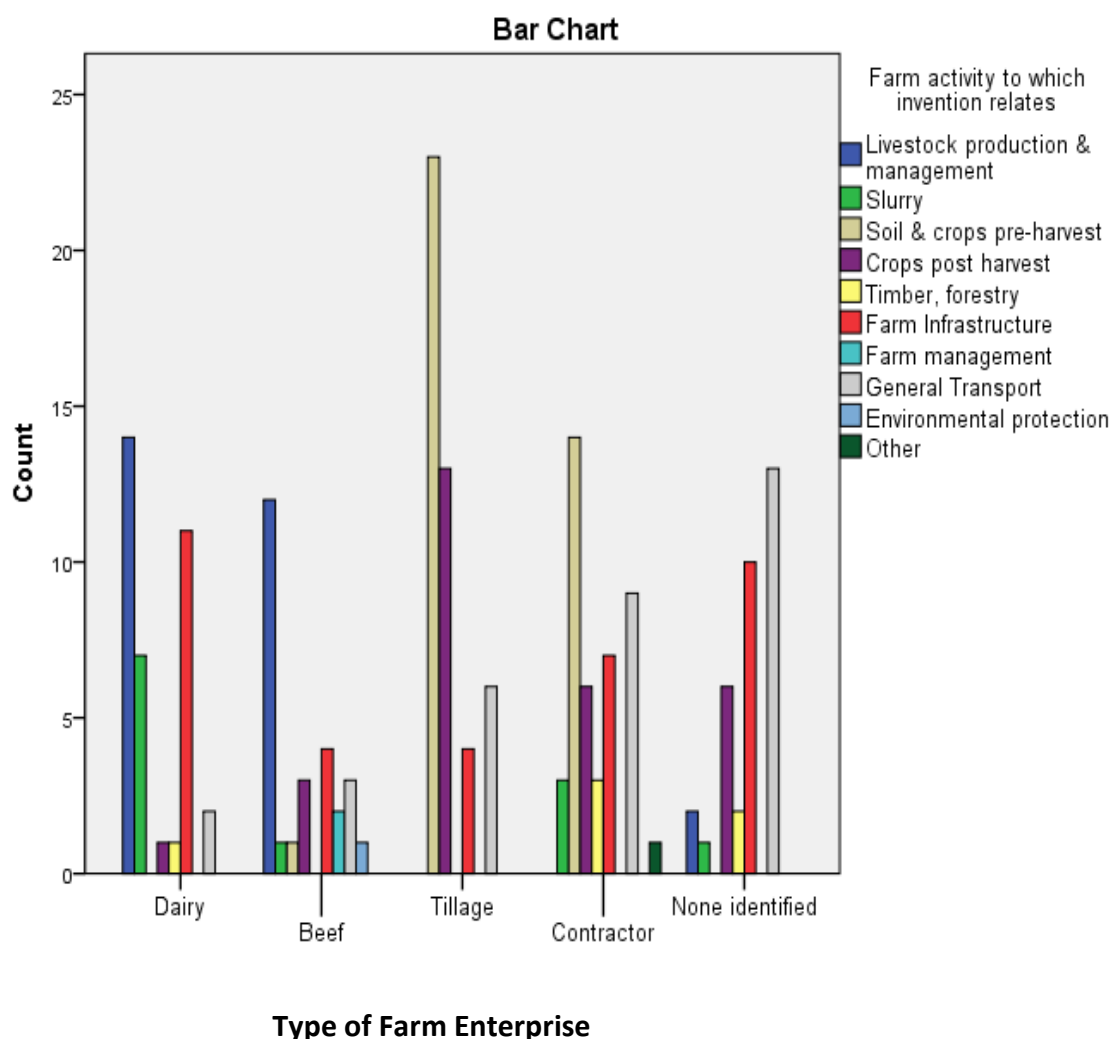


Figure 4.4: Inventions by farming activity and top five farm enterprises, all years combined (Source: author)

4.7 The Direct Benefits Claimed for the Inventions

The primary benefit of the invention to the farmer-inventor is in directly meeting their self-identified needs (Lüthje et al., 2005, p. 952), although the literature on user innovation recognises other benefits of inventing behaviour relating to reputation, reciprocity, and social learning (von Hippel, 2007, p. 297; Henkel and von Hippel, 2003, p. 6). The magazine's editorial policy is economically focused and the invention stories describe the benefits to the farmer of use of the invention. The nine codes used are based solely on benefits identified in the magazine,

that is, claims made by either the farmer-inventor (as told to the editor) or the magazine editor, or both. The codes relating to the benefits claimed are set out in Appendix 2.

Table 4.4 presents the findings for the top three benefits claimed, by year and all years combined. This was a multi-response non-ranked question and the table shows that the top three most frequent benefits were the same and in matching order across the three years, with saving time, or greater convenience for the farmer, the most frequent. This was followed by reduced input costs, including multi-purpose products, and, third, reduced waste.

Year	2003	2008	2013	All years combined
Benefit	1. Save time 2. Reduce input costs 3. Reduce waste	1. Save time = 1. Reduce input costs 3. Reduce waste	1. Save time 2. Reduce input costs 3. Reduce waste	1. Save time 2. Reduce input costs 3. Reduce waste

Table 4.4: Top three benefits: by year and all years combined (Source: Self)

Given the magazine's economic slant, it was expected that the most commonly claimed benefits would be directly economic, and the consistency in the top benefits across the years suggests that the farmers featured are mainly looking for efficiencies in time and costs. While the top benefits may be economic, in 2008, nearly one in five of the inventions were claimed to improve animal welfare or the health and safety of people working on the farm. While a failure to protect either of these would certainly have an economic impact, there are also social and cultural consequences of injuries to farmers or poor livestock management. These relate to understandings of good farming behaviours in a community and as evidence of a farmer's skills and expertise (Burton, 2004, among others). Economic efficiency would also be deemed evidence of good farming behaviour and, in the Irish context, such farmers would also have social status as community leaders (Shutes, 2003, p. 78). This suggests that the farmers' motivators to

invent are not purely economic, and the data relating to social and cultural factors in the Irish context are presented in Chapters 5 and 6.

An example of a time-saving invention story is about a hydraulic tip-up cattle crush (Practical Farm Ideas, 2013, 22/2, p.5) that allows the farmers to inspect the feet of cattle, while they are lying on their side, and carry out any necessary treatment. It is mounted on the front loader of a tractor and, once the animal is strapped in, tips up to allow access to its feet, which are secured to prevent kicking. The alternative is to have the animal standing up in a pen or crush, and lift the feet one by one, manually or with a hoist. This invention is also claimed to improve animal welfare, as well as improve safety for the farmer.

While these findings focus on the benefits claimed for the inventions, the magazine stories cannot be said to present an overly positive evaluation of the inventions; 16 per cent of the sample featured comments, from the farmer-inventor or the editor, suggesting how an invention might be improved. Ultimately, an invention's value is determined by the farmer in use, and I return to the benefits farmers receive from their inventions, as well as the issue of dealing with feedback, in Chapters 5 and 6. This content analysis provides evidence to support the view that the majority of the benefits in direct use of the inventions were reported to be economic, which is consistent with the inventions being livelihood related, yet social and cultural factors relating to good farming criteria may also be an influence. The dominant claims for the inventions in the magazine stories are economic, which might indicate that the farmer-inventor would seek further economic gains through the sale of their invention, yet the findings in the next section appear to be contradictory.

4.8 Free Sharing of Inventions through the Magazine

A defining feature of user innovation is that ideas are shared freely with others in the user community through face-to-face or virtual networks (von Hippel, 2007, p. 294), with only a minority exploited commercially (Shah and Tripsas, 2007, p. 136). The magazine could be described as a virtual user community and the stories provide enough information about the

inventions for other farmers to copy. However, some inventions featured in the magazine are offered for sale or the story informs readers that the farmer-inventor has asserted their Intellectual Property (IP) rights for the invention. This might be through a patent or other forms of protection, which is often a precursor to commercialisation (Lane and Flagg, 2010, p. 4).

The content analysis asked simply if the farmer-inventor was commercialising their invention, in one of the ways described above, and of the total 210 stories analysed, only 8 per cent were offered for sale or described as having some form of IP protection. Publication of the invention in the magazine means that the farmer-inventor cannot subsequently claim their IP rights and, while some small businesses choose informal methods of protecting IP (Kitching and Blackburn, 1998, p. 332), it is possible that the farmer-inventors featured in the sample may not be aware of the implications of submitting an invention, which they intend to sell later, without IP protection. Alternatively, they may submit ideas that have been found not to have commercial potential.

Table 4.5 presents the findings for the three years studied and no immediate explanation for the 18 per cent decline in commercialisation between 2003 and 2013 emerges from either the data or through discussions with the magazine editor (Donovan, 2014). Given the economic slant of the magazine, and the farmer as the source of the story about the invention, it seems unlikely that an intention to sell the invention would be omitted from so many of the articles in the sample.

Year	2003	2008	2013	All years combined
Commercialise? Yes (per cent)	20	5	2	8

Table 4.5: Free sharing of the invention, by year and all years combined (Source: Self)

These results find that almost all the farmers who submit their livelihood inventions, which offer economic benefits to the user, share them freely with other farmers. This includes many contractors, who are already involved in a diversified farming enterprise. As stated above, a

defining element of user innovation is the free sharing of the invention with peers and this content analysis provides evidence to support the view that farmer-inventors are involved in a type of user innovation. Farmers, as established micro-entrepreneurs, would therefore seem to be different to other occupational user-innovators in that they freely share their livelihood inventions. The findings relating to Irish farmers' economic, social and cultural, motivators to share or commercialise their inventions, as well as their involvement in learning communities, are considered further in Chapters 5 and 6.

4.9 The Extent to Which Farmer-Inventors Work Alone

Part of the theoretical understanding of user innovation is that farmer-inventors rely mainly on their own existing knowledge, experience, and skills, without involving external bodies, such as manufacturers (von Hippel, 2007, p. 308). In Chapter 3 I reported that most farmers in the UK and Ireland have no formal agricultural training (Eurostat, 2014, p. 3), while the user innovation literature suggests that user-innovators are science or technology graduates (von Hippel et al., 2011, p. 28). The content analysis asked simply if the farmer-inventor brought in outside help to create the invention. Table 4.6, below, presents the findings in this regard and, overall, 8 per cent of inventions analysed reported outside help, for example with welding or design. This analysis provides evidence to support the theoretical position that the vast majority of farmers invent within their current capabilities, i.e. their tacit knowledge. However, it is possible that an inventor may not wish to admit in a public forum, like a magazine, that they had outside help.

Year	2003	2008	2013	All years combined
Brings in outside help, per cent	13	6	6	8

Table 4.6: Does the farmer-inventor brings in outside help, by year and all years combined (Source: Self)

Looking at the inventions' functionality, there has been a marked increase in the number of Information and Communication Technology (ICT) innovations available on the market for agriculture, and the content analysis also looks at whether ICT is used in any of the inventions. The content analysis finds that, overall, only 4 per cent of the inventions overall involved ICT, with none in 2013 (see Table 4.7 below).

The very low frequency of inventions involving ICT could have a number of explanations. First, the creation of a new ICT product requires a number of different knowledge sets including mechanical, electrical, and electronic engineering, as well as software coding. Most farmers are unlikely to have these skills and acquiring them would involve outside help or require an investment of resources they may not have. However, in the Irish context, the key informants have seen new ICT products in the form of *“software apps for iPads and phones”* (KI 2) invented by the younger farming generation.

Second, in common with the wider population, the current generation of farmers' knowledge and skills do not seem to extend to adaptation of ICT, e.g. mobile phone apps and cloud technology. It could also be said that those using ICT in their inventions, in 2003 and 2008, were early adopters of such technologies, whereas by 2013 most farmers' operational ICT needs may have been met by industry, e.g. robotic and precision technologies, or stand-alone applications, e.g. for livestock monitoring. An example of a farmer's ICT-related invention, from 2003 which predates the widespread use of mobile phone apps, is an alert system on a grain drier which uses a dialler to send a text message to the farmer's mobile phone if the sensors monitoring the drier find it is blocked or has run out of grain. (Practical Farm Ideas, 2003, 12/4, p. 46).

Year	2003	2008	2013	All years combined
Invention uses ICT, per cent	5	6	0	4

Table 4.7: Use of ICT, by year and all years combined (Source: Self)

As with the livelihood focus of the inventions, farmer-inventors would seem to be different to other user-innovators, in terms of their formal educational qualifications. Irish farmer-inventors' education, experience and skills are explored further in Chapters 5 and 6.

4.10 The Form and Effect of the Invention as a Design Improvement

In Chapter 2 the design literature is discussed as offering different categories of invention relating to its effect in terms of the technological or creative development. Initially the study had only two codes relating to the effect variable: incremental and radical. It became clear that these were not sufficient and the third, 'architectural', was added to better describe the significant number of inventions that sit between 'radical' and 'incremental' on a spectrum of creative development. The three innovation effect codes are: incremental, i.e. modification of existing technologies to improve performance or other benefits; architectural, i.e. the combination and/or recombination of existing resources at hand to a new purpose; radical, i.e. a whole new way of doing things following a major technological breakthrough (Norman and Verganti, 2014, p. 82; Howard et al., 2008, p. 170; Henderson and Clark, 1990, p. 3). This variable does to seek to impose a hierarchy of value on the inventions, the codes serve only to describe the different effects of farmers' inventions.

Effect, per cent	2003	2008	2013	All years combined
Incremental	49	48	47	48
Architectural	51	52	53	52
Radical	0	0	0	0

Table 4.8: Effect, by year and all years combined (Source: Self)

Table 4.8 present the findings relating to the effect of the invention. Given that most inventions come from within farmers' existing knowledge and skills, it was expected that there would be no radical inventions, which was found to be the case. It was also expected that the majority of inventions would be incremental, i.e. the farmers were able to access and alter the 'black box' of technology contained in their existing farm machinery and equipment. However, the inventions are almost equally split overall between architectural (52 per cent) and incremental (48 per cent). Architectural is the most frequent across the years analysed, suggesting that the farmer-inventors create new products, using materials at hand, more than they improve existing technologies.

Turning to the form of the invention, the relevant two codes arose from the literature and magazine data and comprise either products, i.e. physical artefacts, or processes, i.e. ways of performing a task or activity. The analysis finds that, overall, 92 per cent of the stories describe inventions that are products, rather than processes. In each of the three years analysed, see table 4.9 below, there is a large majority of artefacts. This may be because farmers submit more artefacts for publication or because it is more straightforward for the magazine editor to collect and publish information and images of artefacts, rather than describe processes in sufficient detail for farmers to copy. This finding supports the decision, based on the extant literature, that the subsequent data collection stages would be concerned with Irish inventors of tangible farming artefacts.

Form of the invention, per cent	2003	2008	2013	All years combined
Product	93	88	97	92
Process	7	12	3	8

Table 4.9: Form of the invention, by year and all years combined (Source: author)

4.11 Conclusions and Further Scoping

For over 20 years, farmers, from Great Britain predominantly, have submitted inventions to a magazine edited by a former Welsh dairy farmer. In this content analysis of three years' worth of stories featured in the magazine, spanning ten years and consisting of a total of 210 stories of mechanical and non-mechanical inventions, I have considered a range of characteristics relating to both the invention and inventor as they relate to the research sub-questions. These are the farmer-inventor's enterprise and location (RSQ1); the activity to which the invention relates (RSQ2); the direct benefits claimed for the invention (RSQ2); whether it is created with outside help or uses ICT (RSQ2); whether the farmer shares the invention freely (RSQ5); and the form and effect of the design (RSQ2).

Given the limitations of the magazine as a data source and its distinctive approach to story collection, the sample is not claimed to be representative of all farmers' inventions. However, the magazine is a unique data source and the findings of the content analysis provide an important starting point for the project in allowing me to get a deep understanding of farmers' inventions, complementary to my immersion in agriculture. It also offers insights into farmer-inventors' behaviours that inform the subsequent data collection in the Irish context, i.e. the key informant interviews (Stage 3) and farmer-inventor interviews (Stage 4).

The content analysis provides evidence to support the view that farmers invent mainly to be more efficient in their farming activities by saving time, reducing input costs, and waste. While this undoubtedly brings livelihood benefits, it is also suggested to be an indicator of good farming behaviour, a means to achieving social and cultural capital in the community (Sutherland, 2013,

p. 436). Almost all the inventions were offered freely through the magazine, seen here as a virtual form of user community, which is consistent with user innovation theory (von Hippel, 2007, p. 294).

Despite the inventions being livelihood related and bringing economic benefits in use, the farmer-inventor's decision to freely share their invention suggests that social and cultural factors influence their decisions, although the magazine may not be their only outlet for promoting their inventions. This apparent contradiction suggests such non-economic, social and cultural motivators relating to reputation, reciprocity, and social learning are preferred over economic profits that might be achieved through sales. However, for some, the response of local farmer peers to their inventing behaviour may lead to anonymous sharing, thereby reducing their opportunities for accumulation of capitals.

Most British farmers have no formal agricultural training and the content analysis provides evidence to support the view that British farmer-inventors work within their tacit knowledge, eschewing outside help in developing their ideas. Previous studies have found most user-innovators to be science or technology graduates (von Hippel et al., 2011, p. 28), but the content analysis provides evidence to support a contrary view. The analysis also suggests that while farmers rarely use ICT in their inventions, just over half of farmers' inventions were found to be of a greater effect, in terms of its novelty or creative development, than was expected. In Chapter 7, I present a multi-perspective view of British and Irish farmers' inventions that compares their mechanical and other characteristics.

Turning to the form of the invention, Hoffman et al. (2007, p. 356-7) find farmers in less developed countries have bred crop varieties and animal breeds, defined classification systems, designed production systems and farm equipment, and developed community-based social innovations. They find that farm equipment is the most common type of innovation, as is the case here, albeit in more developed countries. The prevalence of artefacts in this content analysis, rather than processes or social innovations, may be due to the magazine's editorial

policy, the self-selection of the farmers who submit their ideas, or the ease of featuring tangible products. The finding relating to the form of the invention leads to further scoping of the project and supports the narrowing of the focus of the interview selection only to farmers invent artefacts in the Irish context.

While the data on the farm enterprise in which the invention arose is incomplete in 16 per cent of the cases, the cross-tabulation of farm enterprise and the activity to which the invention relates suggests that farmers, including contractors, from a range of farm enterprises invent across most farming activities. This leads to the Stage 4 interview selection being non- enterprise based, that is farm enterprise is not considered a defining factor for the purposes of this study. Equally, farming activity, ICT, gender, and age are not considered in the participant selection.

In this chapter I have contributed to the research aim of this thesis, which is to investigate farmers' inventing activities, by providing evidence to support the view that farmer-inventors in more developed British agriculture are involved in user innovation, albeit from a livelihood perspective. I also offer new insights into farmers' inventing behaviour in freely sharing ideas, the invention process, and the benefits gained in use of the artefact.

The user innovation process, particularly the free sharing of inventions, cannot be explained by extant economic theories and the approach here is to build on the findings of this content analysis by considering, in the following chapter, interview data from a sociological perspective, using Bourdieu's (1986) theory of economic, social, and cultural capitals.

Chapter 5 – Farmers’ Motivators for Invention

5.1 Introduction

In the last chapter, I presented research findings that provide evidence to support the view that farmers’ inventions are mainly aimed at bringing about livelihood benefits through various types of efficiencies. The inventions either improve an existing technology or repurpose materials at hand; most emerge from the farmer’s tacit knowledge. Almost all the inventions in the sample are shared freely through the magazine, rather than offered for sale. This is largely consistent with user innovation theory (von Hippel, 2007, p. 294), as well as the literature on farmers’ behaviour, and suggests that social and cultural factors can outweigh potential economic benefits in the farmers’ decision making.

In this chapter, findings relating to farmers’ motivators for inventing and, where relevant, commercialisation processes are considered from a sociological perspective, focusing on economic capital and embodied cultural capital. I use the phrase ‘knowledge and skills’ on occasion to differentiate a point from the wider set of valued behaviours that may be considered as ‘embodied cultural capital’. I apply Bourdieu’s theory of capitals (1986) to interview data collected through in-depth narrative interviews with five farmer-inventors, as well as semi-structured interviews with five key informants (KIs) from formal knowledge and innovation support organisations. It should be borne in mind that these are not claimed to be representative samples.

In this chapter I consider first the findings relating to research sub-question 3 (RSQ3), ‘To what extent are farmer-inventors motivated by economic, social, and cultural factors?’ as it relates to the subjective values and emotions that underpin inventing behaviours. I find that passion, perseverance, and optimism drive the farmer-inventor participants to pursue intergenerational family and farm resilience, job satisfaction, and technological progress. They rely on support from their wives and families in the development and subsequent sharing or commercialisation of their inventions.

Second, I look at RSQ3 but in relation to economic motivators and commercialisation, whether intentional or incidental. I find that the economic benefits gained through use of the invention described by the farmer-inventors mirror those in section 4.6 above. Making money from the sale of their inventions is a consideration for all the participants, as evidenced by them having looked into, or thought about looking into, the patent process. However, the farmer-inventor participants take differing positions on seeking economic gain through commercialisation of the invention, ranging from having a clear intention to do so to having no interest at all. Two have successfully applied for patents but those attempting commercialisation must invest additional economic capital and embodied cultural capital in order to have a chance of succeeding in an increasingly competitive market.

Third, I present the findings for research sub-question 2 (RSQ2), 'How do farmers approach the invention process?' as it relates to farmer-inventors' knowledge and skills. I find that farmer-inventor participants identify a shared repertoire of knowledge and skills, which they claim is different to that of other farmers. It is acquired through social learning and they are disappointed by the knowledge hierarchy that values formal learning over tacit knowledge. Farmer-inventors who display their knowledge and skills publicly often receive a hostile response from fellow farmers, yet they are not deterred. The key informants suggest that such a response, to what may be perceived by other farmers as a waste of knowledge and skills and inappropriate self-promotion, is a feature of Irish farming culture. I conclude this chapter by summarising and discussing the findings.

5.2 Data Presentation and Farmer-inventors' Cameos

5.2.1 Data Collection, Analysis and Presentation

Data collection took place in Ireland during 2015 and the interview data were analysed using a thematic approach. The farmer-inventors' narratives appear under the identified themes and data from the key informants is included where there are divergences in perspectives between the two groups or the key informant offers an additional perspective. Where no key informant

is quoted, it means that the views are either in concurrence with those of the farmer-inventors or absent from the data; this is identified at relevant points in the text.

I use pseudonyms for the farmer-inventors when directly quoting or referring to them, while the key informants are, for simplicity, identified by codes (KI 1-5). When directly quoting the participants, repetitions and filler phrases, such as “*you know*” are replaced by “...” for ease of reading, while “[XX]” is used to replace information that might identify a person. We now introduce the research participants.

5.2.2 Who are the Farmer-inventors?

In this sub-section I present cameos of the five farmer-inventors, using pseudonyms and without revealing information that may identify them. All are active inventors and all but one conventional farmers.

Francis is a retired dairy farmer who lives in the Mid-West region. He did not go beyond school education and in the past was active in farming organisations. He enters local and national invention competitions and holds a patent. His inventions include: self-powered turf turning machine; castration guard; calving aid; self-powered yard scraper; crush back up bar. He has both shared and commercialised his inventions.

Kevin is a tillage and beef farmer who lives in the Mid-East West region. He did not go beyond school education and is very active in farming organisations. He does not enter invention competitions and prefers to freely share his inventions. His inventions include: tilting land leveller, combined harrow and drill, gearbox bearing remover, cattle dosing system.

Mark is a dairy farmer who lives in the South West region. He did not go beyond school education and is active in farming organisations. He enters local and national invention competitions and is mainly interested in commercialising his inventions, but he will also share. His inventions include a combined baler and wrapper.

Alan is a mixed organic farmer with beef, pork, poultry, and agroforestry enterprises. He lives in the South East region. He did not go beyond school education but did a farming apprenticeship in Germany. He does not enter invention competitions and is not interested in commercialising his inventions. He is very active in farming organisations and environmental campaigns and contributes to PFI magazine. His inventions include: working platform, front loader implement, workshop organiser, and adapted post driver.

Declan is a retired dairy and beef farmer who lives in the South West region. He did not go beyond school education and in the past was very active in farming organisations, including farming protests. He enters local and national invention competitions and holds a patent. His inventions include: mechanical calf feeder; clean water system; mobile poultry house, post driving system. He is mainly interested in commercialising his inventions. We now turn to a discussion of the farmer-inventors' values and emotions.

5.3 Farmer-inventors' Personal Values and Emotional Spurs

In this section, farmer-inventors' values and emotions are presented as fundamental motivators for their inventing behaviours. Values are understood to be part of an individual's habitus, i.e. their internal dispositions, while emotions are valued as embodied cultural capital or as a social practice (Scheer, 2012, p. 220).

5.3.1 Personal Values – Farmer-inventors' 'Habitus'

The literature review found farmers have complex value systems, which are considered here as powerful influencers on inventing and entrepreneurial behaviour. Duesberg et al. (2013, p. 161) finds that meeting non-economic values seems to compensate Irish farmers for lower profits and are seen as culturally appropriate. They describe a number of non-economic values (enjoyment, family tradition, meeting a challenge, and nature conservation) which also featured in the participants' narratives.

All the farmer-inventors get great satisfaction from the design process and the artefact produced. One cites a 19th century hymn to explain his sense of pride in completing a task, while another declares the sense of achievement in the finished product to be worth more than money:

“that’s why I’m saying, ‘there’s joy in labour found’, ... no matter who you are in this world, if you’ve done some job during the day that you can see done, there’s a sense of pride, regardless of how menial or how large the job is” (Mark)

“I felt a great joy in seeing that the thing worked, ... because you get frustrated at a thing, and you take it on and it doesn’t work... and the joy of achieving it, ah it’s, it’s very hard to describe the thing... you’re inventing things, you don’t look at it from a monetary angle. It’s just the satisfaction of getting the thing to work” (Francis).

Another farmer-inventor introduces a competitive element and enjoys being the first in his field and to succeed in the face of opposition:

“Well, the biggest thing I’m interested in ... is doing something that nobody did before. And, most of the things that I’ve done, I’d have succeeded where nobody would have actually seconded me. That’s the one I like ... if I can do something that nobody would agree to do it that way, and it succeeds, I did it!” (Declan).

Apart from their personal satisfaction, providing for their children’s future is a high priority, for example, to pay for college fees (Declan) and the continuation of the family farm and preserving the close family unit:

“The ultimate dream, then, for all of us is that ... you would grow a business that would be big enough to support maybe one or two of the family members, and they’d all stay ... close enough to the nest as such, ... I think most farmers like to try and keep the family at home... whereas most other parents want to get rid of them as soon as they can... [Laughs]” (Mark).

While inventing may be a route to improving future farm resilience through increasing or diversifying income, the invention and adoption of new technologies is also a way to move on from the labour intensive farming of the past: *“I wasn’t technically going to farm like my father farmed, and I told him, I was going to farm but I wasn’t going to farm with a fork, I was going to farm with a machine”* (Kevin). One of Declan’s inventions was inspired by his mother’s heavy workload and early death: *“My mother died suddenly, when she was 57, and she never lived, because all she did was slave ... but she was a great woman ... that would bug me a bit, that my mother had to work so hard”*. His labour-saving calf feeder aimed to improve life for other Irish farm women, and he is confident that he succeeded: *“My machine was there doing the feeding, and she could go out in the middle of the day, or at any time that suited her, and pump in the milk, and wash the machine, and she was free after that, and I had more women fans ...”* (Declan).

Independence and self-sufficiency are similarly prized in the context of the family’s past and future prospects, and the understanding that decisions taken now will have an impact on future generations. One farmer-inventor directly links his inventing with a family tradition of self-employment and living on their wits:

“this is where invention comes again. All my people before me, they all lived out of their head. They had to invent a way of making a living all the ways down along, ... when I was inventing I never wanted to reach the stage where I worked for somebody else” (Declan).

This intergenerational focus attempts to reconcile current and future needs with an appreciation of the struggles of earlier generations. Forward planning extends to the value placed on nature by the farmer-inventors: *“we’re all only using it, it belongs to nobody ... you have a product that God gave you ... and if you blackguard it, well then”* (Francis).

Maintaining the farm is a family endeavour and the farmer-inventors acknowledge their wives’ support as essential to their inventing activities: *“I had all the family killed as well with it ... because herself, in fairness ... she did the phone and she did everything, and I was on the road and she was doing the farm”* (Declan). Children may be a source of knowledge and skills to support development (Kevin) or commercialisation (Declan) of the invention. In the father and

son scenario, each acknowledged that having experience and up to date knowledge, *“an old head and a young head working together”* (Mark), brought benefits, as well as tensions, when developing new ideas. Family support can free the farmer-inventor to pursue their activities, yet, according to one key informant (KI 3), it may not always be forthcoming and thwart the farmer’s invention plans.

The reverence for family and land does not extend to big business, government and their agencies. All of the farmer-inventors appreciate transparency and honesty from others, and expressed scepticism about vested interests that, for example, disregard traditional knowledge (Francis), promote unnecessary pharmaceutical products (Declan), stifle innovation (Mark), manipulate scientific studies (Alan), and give inconsistent farming advice (Kevin).

The farmer-inventors also have interests beyond the farm gate. They describe their past and present activities in relation to the wider farming and rural community, which include: involvement in setting up invention competitions; putting forward ideas for rural development projects, such as hydroelectric schemes; being a founder member of a dairy co-operative; being a leading member of Macra na Feirme²; being an organic pioneer in Ireland; being active in local and national environmental management groups. This suggests that the farmer-inventors have some experience in the public eye, which is explored further in section 5.5.3. Farmer-inventors’ values are described here as relating to job satisfaction, preserving the family farm, and improving their children’s prospects, as well as broader community concerns. Next, we consider farmer-inventors’ emotional spurs.

5.3.2 Farmer-inventors’ Emotional Spurs – Embodied Cultural Capital

From a Bourdieusian perspective, as discussed in Chapter 2, emotions can be regarded as social practices, culturally appropriate according to the social structures within which an individual operates (Scheer, 2012, p. 202). Emotions, such as love for family and commitment to the farm, are found to affect farmers’ decision making (Katila, 2002, p. 188). Farmers have a strong sense

² Macra na Feirme is the Irish young farmers’ organisation.

of duty to honour previous generations by maintaining the family farm, that in the breach bring shame and guilt (Katila, 2002, p. 188). This is echoed by the farmer-inventors:

"I had the alternative there that I could have rented the farm, and I could have gone off and taken a job, at the time ... but I have never worked for anyone, and my father never worked for anyone, and any one of my forebears back to 1450, they never worked for anybody" (Declan).

The key informants suggest that inventing behaviour by smaller or part-time farmers, especially where local sharing of resources has been monetised, may also be motivated by "survival" (KI 5) or resilience imperatives.

Farms are also micro-enterprises and the entrepreneurship literature provides emotional explanations for certain behaviours described by the farmers as relating to their inventing. Optimism is linked to initiating new ventures: *"we'd always be hoping then that the next idea would be the One, or the idea we have would be the One... we would make life easier and ... if the idea worked, would be to supplement income in an off-farm way"* (Mark). Passion (pleasure from engagement in meaningful activities linked to self-identity: Cardon et al., 2009, p. 515) drives perseverance to overcome obstacles and solve problems:

"Oh, I carried on, oh yes, I persevered ... I'd stay going night and day, sure. The old workshop above, I'd be out, maybe put on an old fire, and sit down on an old five gallon drum. She'll come out, giving out, 'come in out of there, come in out of there'. This could be ten or eleven or twelve o'clock at night. Still, I'd go to bed then, still lying in bed thinking of... going through whole picture of the thing, through your mind, you'd see, it's amazing and ... when you have the thing done to a point, ... well, you can only improve it from that point on ... so you'll always see something to improve it then" (Francis)

"I would say it's a bit of a disease ... I'm always on projects, even when I'm doing nothing, I'm on projects ... and I go back to it ... I go back to it again, and I look at it again" (Declan).

Perseverance is also seen in the farmer-inventors' positive attitude to failure, an important factor in sustaining interest through the trial and error stages of the development of an idea: *"if you don't try a thing, they say you fail, but you never fail. If you try a thing, you never fail ... you try it and it opens your mind"* (Francis). The participants also spoke of their delight in tools and tinkering: *"Oh, it's enjoyable, I love it. I love messing with things"* (Francis), while Alan describes himself as a *"machinery freak"* who sees farming, in some ways, as a kind of *"technical challenge"*, and says *"I'm probably better equipped than some small workshops or garages, and I love, just love, technical work."* For another, there is a tension associated with the making of a product, an unpredictable element in the manufacturing process, which brings satisfaction with each successful outcome:

"We turn sand and cement into troughs. And it's a bit like the oven, every time we take them out of the moulds, there's an anticipation that, 'Jesus, I hope they're not cracked or I hope there aren't chips out of them' ... every one of them we open is still the same as the first one we opened" (Mark).

However, passion can tip over into unhealthy obsession and the farmer-inventors recognise that their inventing sometimes takes priority over farm work *"I'd even get the old cows and milk them up quick to get back at something even. That's the way, yeah"* (Francis), and family life *"Now, I get into a pile of trouble in my own house here ... my wife says, 'oh', she says, 'you're stuck on this and you're stuck in that and you're stuck', but, I mean, I'm not really"* (Declan). They have also seen the effect on another family's financial prospects:

"You can believe in your product too much, and you don't know when to say stop... I have friends that are paying second mortgages because they believed too much in the product they were in. And we told them that, 'stop' ... the problem is that it is like anything ... the more you feed it, the more you have to feed it, and then you've so much put in that you can't stop" (Mark).

Many inventions never achieve market success, despite significant investment of capitals, and the farmer-inventors' commitment, optimism, and perseverance suggest an emotional

repertoire that may be, more or less, skilfully deployed in the pursuit of their inventing and entrepreneurial goals. In seeking to improve family farm resilience, the farmer-inventor is engaged in meaningful activities, which also bring great personal satisfaction. These kinds of social and cultural factors motivate the farmers to invent, although one key informant denies any social influences, stating that inventing is needs based (KI 2). We now turn to the economic influences on farmer-inventors.

5.4 Economic Motivators and Commercialisation

5.4.1 Economic Benefits from the Inventions

I presented in Chapter 4 research findings that provide evidence to support the view that farmers invent in relation to their farming activities, a process which requires an investment of both economic capital (money, materials, time, labour) and embodied cultural capital (knowledge and skills). It is not surprising then, that all the farmer-inventors interviewed mention economic benefits, which I define here broadly, as desirable outputs of the invention, but also that the anticipation of such benefits is a motivator to invent. The economic benefits described include increased efficiency through use of the artefact, e.g. saving time, reducing labour and other inputs; saving money on new equipment and professional expertise through DIY; making a job less physically demanding; and protection of farm assets by improving health and safety and animal welfare. This accords with the findings in section 4.6 in the previous chapter. The motivators of those farmer-inventors who seek to make additional income through the commercialisation of their invention are discussed in the following sub-section.

For one farmer-inventor, saving time and reducing labour are the benefits of his latest invention: *“it’s a one man job. Couple of bangs down, and then I’m gone onto the next one”* (Declan). Reducing the physical demands of a task is also important: *“the turf turning machine was another thing which... took the hard work out of the back breaking job”* (Francis). Inventing from necessity, or DIY, described by Bourdieu (1986, p. 258) as the *“cash savings of the poor, which are paid for in time”*, is seen by one farmer-inventor as a motivator for invention more widely: *“it’s due to a lack of money that a lot of these invention are made in that ... people can’t afford*

to buy ... what they need to do the job, so they make something, or some kind of an effort at whatever it is, rather than buy" (Mark). This is also the case for the individual farmer-inventors: *"necessity caused it too, that I had to do it. I couldn't afford to pay people to go and do it, with a small farm, you couldn't afford to pay"* (Francis). The key informants note that in the case of part-time farmers, time saved is devoted to off-farm work or developing new income streams (KI5). Others are determined to save money through maximum usage of discarded materials: *"I'm a born recycler, I throw nothing out... I take anything I can get for free"* (Alan). Some farmer-inventors also improve and adapt machines, recently bought for thousands of euros, to suit the exact needs of their farm:

"Participant: and I only bought that last year and already there's two or three [Laughs] improvements and add-ons to that that I can do to make it better

Interviewer: and can I ask you how much you paid for it?

Participant: four and a half thousand, plus the VAT" (Kevin).

Some farmer-inventors will invest considerable sums in building their own machines and the cash savings will be in the thousands due to the high costs of new farm machinery. Shortage of ready money may not be the only motivator in such cases, the key informants suggest that the need for machines exactly suited to farm conditions and the farmer's trust in the quality of their own work, might also influence decisions to DIY (KI 4).

Inventions are also aimed at protecting the health and welfare of the farmer and livestock, which are important farm assets. One has designed a clean drinking water system: *"It is unclean water, but these cows have no alternative but to drink that water or die of the thirst"* (Declan), while Francis' castration guard serves a dual purpose, to protect the farmer's safety, as well as that of the animal:

"in relation to the castration guard that I invented ... it was a dangerous job to do... you wheeled it in behind the animal, then went in between the animal's legs so they couldn't

kick or fall down. Which was a problem with ... the castrating... when the pressure came, the animal got weak and fell down, so you couldn't get him up. But he couldn't fall down with this thing and it held him up, and he couldn't kick you."

Achieving these kinds of time, labour and cost savings influence a farmer's decision to invent, yet the key informants seem to approach farmers' inventions from a more business focused perspective, i.e. the value of the invention is in its business potential, rather than its benefit to the farmer. One describes his understandings of farmers' inventions as *"something that's novel, that gives competitive advantage, particularly in the context of export markets"* (KI 2). Further benefits are achievable by taking the invention to the next stage, that is, the wider diffusion of the invention beyond the farm gate. The user innovation literature discusses two possible courses of action, suggested here to be direct and indirect routes to increased economic capital. This accords with Bourdieu's (1986, p. 243) assertion that capital conversion strategies may involve the substituting of economic capital with social and cultural capital in order to secure future economic benefits. Free sharing of the invention (findings in this regard are in Chapter 4 and Chapter 6) is described here as an indirect route, involving the conversion of capitals, while taking the invention to the market is considered a direct route. In the next section, we look at what might influence farmer-inventors' to seek further direct economic benefits from the sale of their product.

5.4.2 Farmer-inventors' Entrepreneurial Intentions

This sub-section considers farmer-inventors' inclination to directly increase their economic capital through commercialisation of their inventions, an activity described as *"user entrepreneurship"* (Shah and Tripsas, 2007, p. 124). The content analysis found that only 8 per cent overall of the inventions featured in the magazine were commercialised, although the contributing farmers might use alternative means to sell their inventions. While three of the five farmer-inventor participants had attempted to exploit their ideas, with varying degrees of

success, all had thought about it. We also hear about their experience of commercialisation, the obstacles they face, and their attitude towards financial risk-taking.

All of the farmer-inventors acknowledge that money is tight at times, even to the extent that the farm is at risk:

“I was able to carry on even though times were hard and money was scarce” (Francis)

“Money was always short my whole life. My whole life centred around making ends meet.

I had never ever money to spare for whatever luxury” (Alan)

“I was after running into brucellosis and I had got myself into very serious financial situation, and I was in danger of losing the farm” (Declan).

It might be expected, therefore, that the farmer-inventors, as micro-entrepreneurs, would want to commercialise their inventions in order to increase their economic capital.

A first step to commercialisation is the protection of their Intellectual Property (IP), which all have considered. Two of the farmer-inventors interviewed have patents (Francis, Declan), yet for the others the patent process appears to be expensive, time consuming, and, probably, ineffective at protecting their IP (Mark, Alan). There is also a perception that some of their ideas might be insufficiently novel or are too simple to qualify for a patent (Alan, Kevin). The farmer-inventors' views on IP breaches and the patent as a form of formal validation are discussed in Chapter 6. All of the farmer-inventors are aware of the need to protect IP prior to commercialisation, yet there is no dominant narrative in relation to their willingness to commercialise their ideas.

Some of the farmer-inventors actively consider the sales potential of their ideas: *“one or two of the things we made to make life easier, we thought there was a market for them”* (Mark), while another is looking only to recover some of his costs: *“If you can sell a couple, just to recoup some of the expenses, ... that’s a bonus. But money wouldn’t, it wouldn’t interest me”* (Francis). Others are more definite about not seeking to make money from their inventions, preferring to share

with other farmers. However, one dismisses the idea of free sharing, insisting that, if the work of setting up a new enterprise is taken off the inventor for example by licensing their product to a manufacturer, all farmer-inventors would welcome a financial return for their idea: *“there is plenty of other guys that would have plenty of ideas saying, ‘Jesus, that would be all right, sure, if the other crowd are making it, ... we’ve nothing to do, the work is done’... would be money in it for everyone”* (Mark). Mark is a long time farmer-inventor, knowledgeable about agricultural innovation in Ireland, and this comment suggests that he is not aware of any agricultural machinery manufacturers that might be employing lead user processes to actively identify farmer-inventors whose novel ideas may have commercial potential. The onus seems to be on the farmer to make the approach. Overall, despite taking an idea to the market appearing to be a major undertaking for the farmer-inventors, some have attempted to do so.

5.4.3 Farmer-inventors' Experience of Commercialising Their Inventions

We now explore the experience of the three farmer-inventors' (Francis, Declan, and Mark) who have taken inventions to the market. Apart from the free family support discussed above, the farmer-inventors believe they have some advantages over other businesses in relation to: time to develop ideas, *“there are certain times of the year where we would have a lot of free time”* (Mark), and availability of materials, *“there’s always a time you need a bit and you haven’t it, and you go out to the old... scrapheap and you pick up”* (Francis). A major advantage is suggested to be in the matter of start-up costs:

“there was no wage needed to be paid, and then there was no premises had to be paid for, and there was no company cars needed, because there was transport already available in the yard... when you’d roll all that in together... the starting cost base would be zero... for someone else, they’d have to get a large grant to be starting in the same place as where we’re probably starting... I suppose we’d have an advantage before starting” (Mark).

Despite their better starting position, the farmer-inventors face challenges in their pursuit of economic capital. Apart from the time and money involved in developing an invention, commercialisation requires an additional investment of money to, for example, upgrade workshops and order materials (Mark, Francis), cover patent costs (Francis, Declan), maintain records and book-keeping (Declan), and comply with rules and regulations (Alan). The farmer-inventors have different attitudes to financial risk. One has converted economic assets, in the form of shares, into cash to invest in commercialisation of his idea: *“we have that little business now, we have it up and running ... I spent about 30,000 of my own money in it ... I have shares actually in [XX], and I sold shares”* (Declan).

However, a reluctance to significantly increase farm debt was evident, particularly to the extent that it might jeopardise the family farm, suggesting some have a more conservative approach to financial investment:

“if a fellah comes into me and he tells me ‘... I see there is value in your idea, but you’re going to have to invest 100,000’. I say to the wife ‘Jesus, they’re happy with the idea and I have to put in 100,000’, and she’d be, ‘Oh Jesus, that’s great, yeah, and what happens if it doesn’t work out?’ ‘Ah sure, it’s fine, sure it’ll only be another mortgage for 100,000, it’ll be fine’. But that’s not the reality of it, the reality of it is ... you’d be stuck with another hundred thousand” (Mark).

While not all inventions will require an investment of hundreds of thousands of euros, a lack of economic capital militates against taking the invention to the next stage: *“when you haven’t money to do a thing, well, you’re at nothing”* (Francis). Taking sufficient time out from farming activities to run an invention business is difficult for those who farm alone (Francis, Mark). Balancing the demands of running a farm and family life can also be off-putting for the farmer-inventors interviewed: *“if he’s to try and manage his farming business and his invention business and his family life... I think it’s virtually impossible for him to succeed because... there isn’t enough time in the day to do all of the above”* (Mark). For those who succeed in commencing a business,

it is emphasised that there is a price to be paid: *“this is what doing things leads to... long hours and unreasonable hours”* (Declan). One of the key informants suggests that farmer-inventors were more likely to be full-time farmers as *“they had time to refine and time to chase it, whereas the part-time guy’s working and ... he or she hadn’t the time to”* (KI 5).

Taking the entrepreneurial route requires the farmer-inventor to perform a range of new, and unfamiliar, roles:

“I invented it, and I had to make it, and I had to put it together, and to sell it, and collect the money, and try and keep it going, because it was a very tight margin, you know”
(Declan)

“it’s a different environment, because it is ringing this fellow, and it’s going to meetings here, meeting solicitors and accountants and banks and enterprise boards, and all these. And all these things are not things that he is normally used to doing” (Mark).

To perform these roles successfully involves acquiring additional knowledge and skills and one key informant suggests it is unusual to find a farmer who has the combination of inventing flair with the strategic skills required to start a new enterprise: *“they’d be creative thinkers, and there’s also the need of the business person that can shape it up. It’s quite hard to get one person that can do all”* (KI 5). The farmer-inventors also recognise where their skills might be lacking:

“I never got the proper exposure because my public relations wasn’t good enough”
(Declan)

“a lot of these ideas would fall on their face from that point of view, in that any of the above roles we wouldn’t be qualified, ... most farmers wouldn’t be qualified in any of the above roles or positions” (Mark)

“the salesman was the important job... you can make hundreds of things but if you can’t sell them, you have nothing” (Francis).

One key informant mentions market research as an important activity that the farmer-inventors often overlook: *"I'd never say a farmer doesn't understand the market ... I think it's probably that they haven't done their research"* (KI 2), he finds that the farmer-inventors *"address a problem that they have, but they don't address market gap"* (KI 2). However, the farmer-inventors demonstrate their awareness of market issues: *"most farmers would be inventing things that other farmers want. So, we're already dealing with our own"* (Mark), as well as the trends that can affect sales, *"I made a few [castration guards] ... I sold them, but then ... the trade, it kind of stopped because people began to ... rearing bull beef. So they didn't castrate them"* (Francis). Some believe the market determines which products do well and which fail: *"all the good products succeed, anyway, because they get used... the bad ones just die themselves"* (Declan). However, the farmer-inventors recognise that the market is changing with the greater involvement of multinational companies and proprietary agricultural technologies:

"the only thing we do find is that getting product on to the market now is a lot harder than what it was ... 20 years ago" (Mark)

"it's very hard for anyone to fit themselves into that, because they just wouldn't have the specialists that these fellahs have in the different things, ... all the chemicals that are being used for cleaning milking equipment, my God, some of the top companies in the world are in there, ... they're all fighting for that market there, ... you couldn't, very hard to fit into that" (Declan)

"We are now exposed to the world markets, and Ireland... we are too small ... I'm talking ... about a market of consumers, 800 million in Europe, looking for quality, for speciality, have the money to pay for it. That is the market. We shouldn't discuss GM, we shouldn't discuss Roundup. We should produce for this market" (Alan).

In this sub-section the farmer-inventors' confirmed their understandings of the investments required for commercialisation and the realities of the market. Commercialisation of an invention requires additional economic capital as well as entrepreneurial knowledge and skills,

and in the next section we discuss the farmer-inventor participants' skill set, its acquisition and public display.

5.5 Farmer-Inventors' Identity, Knowledge, and the Social Repercussions of Inventing

Farmers' tacit knowledge and skills are acquired mainly through social learning and is a form of embodied cultural capital (Bourdieu, 1986, p. 244). These capabilities are, to a greater or lesser degree, shared between farmer-inventors, and between farmer-inventors and other farmers. However, the exhibition of a farmer-inventor's knowledge and skills does not always get a positive reaction from their peers.

5.5.1 Farmers' Inventing Repertoires

The farmer-inventors distinguish similarities and differences between themselves and other farmers, as well as traits in common with other farmer-inventors. These indications of distinction are viewed by Bourdieu (1986, p. 245) as a form of cultural capital that enhances an individual's social status. This kind of recognition also resonates with identity theory, which views identity as socially constructed, with an individual able to adopt multiple identities, including in relation to their farming occupation (Burton and Wilson, 2006, p. 98; Brandth and Haugen, 2011, p. 37).

The prospect of a farmer's identity extending to incorporate inventing or, indeed, the notion of a distinct farmer-inventor's identity, only emerged during the data collection. The participants describe their activities as 'inventing' and some describe themselves as 'inventors'. During one interview, I saw prizes for inventing on display in the family sitting room and a file of press cuttings labelled 'Inventions', while the farmer's family also referred to his inventions. It was clearly a meaningful activity and somewhat distinct from the farming role. An in-depth discussion of identity, however, is beyond scope of this chapter, which, instead, adopts a Bourdieusian lens to present this type of peer recognition as a form of symbolic capital. Issues of identity are considered further, in Chapter 6, in the context of farmer-inventors' social learning networks.

First, the participants acknowledge that farmers generally are inventive: *“Every farmer has his own little thing ... Farmers are inventing always different ways of doing things”* (Declan). Problem-solving to suit the specific farming context is thought to be commonplace: *“all farmers are inventors... every farmyard is different, every farmer has to come up with his own ideas to ... make life easier for him on his farm”* (Mark). However, they also cite ways in which they are different to other farmers.

One suggests that other farmers approach ideas less systematically than a farmer-inventor might: *“they see an idea, and they put it to use in a crude kind of a way, which maybe doesn’t eliminate labour as much as the way the thing is made first, and they just go in a haphazard way with the idea”* (Francis), or they do not make inventing a priority: *“the true farmer is ... going to say ‘Jesus, I can’t be doing that because I have to be at home, cows need milking, or cows need feeding, or the calves need feeding’”* (Mark). The ‘true’ farmer is committed to the farm over the invention, while another hints that farmer-inventors are particularly gifted:

“whether a genius would be compared to an inventor, I don’t know... there’s nothing really great about a genius, because a genius is only a person that sees the need for something and supplies it... he often is not very smart, but he has this thing, he’s somebody that just sees the obvious” (Declan).

The farmer-inventors claim to be ahead of other farmers and willing to change:

“that’s our mentality ... but the ordinary person won’t, they’re not inclined to go that way or not inclined to ... change a thing, or change the habits that have formed over years”
(Francis)

“Inventing means some kind of changing to something new and getting rid of an old system” (Declan).

It was suggested that other farmers’ resistance to change is due to fear of standing out from the crowd or of the unknown:

“people are afraid to do something different from what anyone else does... when it became knowledge that I’m going organic, some people stop saluting. Farmers avoided talking to me, because I did something they deep down felt they could do as well, but they were not brave enough” (Alan)

“people wouldn’t understand what you’re doing ... they say ‘you’re nuts’” (Francis).

Some of the farmer-inventors experience ridicule from other farmers, which reinforces the perceived differences between themselves and other farmers. They actively identify with the creative process; most describe their activities as inventing, while some refer to themselves as inventors (Declan, Mark). Others are less sure, as seen in the responses to the question *“Would you see yourself as a farmer or an inventor or a farmer-inventor?”*

“... when you get the bread-and-butter, sure it’s farming ... it would be farming, number one. The rest would be only a hobby or incidental. But... it would be very much intertwined in farming, and it would be all geared for farming ... a lot of the things I did were ... 90 per cent farming anyway” (Francis)

“I think everything ... I see myself as a person living on this planet with the aim to leave something worthwhile to continue behind” (Alan)

“No, a chancer [Laughs]” (Kevin).

Alan and Kevin do not describe themselves as inventors, nor do they exhibit their inventions at the agricultural shows (see section 5.5.3 below). On the other hand, Francis is the only farmer-inventor who describes his inventing activities as a ‘hobby’ because he sees farming as his main source of income, yet he enters agricultural show competitions, holds a patent, and has attempted to commercialise some of his ideas. The key informants claim that, for some, *“it’s their outlet as opposed to a job”* (KI 5) and for this group of participants there are mixed views as to whether their inventing is as significant to them as their farming.

The farmer-inventors also talk about “*real inventors*” (Mark), particularly the Irish inventor Harry Ferguson (Declan, Francis, Alan), who, in the 1930s, invented the hydraulic three-point linkage for tractors that is still in use today (Dieffenbach and Gray, 1960, p. 44). Declan is inspired by Ferguson to use his family name for his invention:

“Harry Ferguson put his name to it ... when I came up with my invention and I felt myself that it was so good, I said ‘It is good enough to put my name on it’... anybody that comes up with something that’s good enough should have their name on it”.

In this way Declan makes distinct to customers and interested others his role in inventing the machine, an important performative element of his farmer-inventor identity, and an indicator of his embodied cultural capital.

The farmer-inventors are also familiar with Ferguson’s relationship with Henry Ford, which ended in a court battle over patents (Kaufman, 1958, p. 466), which the farmer-inventors describe as a “*big hassle*” (Francis) and it presents a cautionary tale: “*Harry Ferguson had pieces that Henry hadn’t got then, and Henry had the money and Harry Ferguson hadn’t ... but they went on and they finished up in a big court case, millions*” (Declan). Ferguson’s story seems to be a shared point of reference, even though the participants do not know each other, and they also mention similarities between themselves as farmer-inventors relating to commitment and competitiveness: “*And I know from listening to the rest of the fellahs at the shows, they’re the very same... perseverance and win the day if you can*” (Francis). We saw in Chapter 2 that membership of a community, evidenced by shared practices, contributes to identity formation (Wenger, 1998, p. 149) and entering the invention competitions at agricultural shows is suggested here to be an important opportunity to perform the identity of a farmer-inventor and to meet other farmer-inventors; the findings in this regard are discussed further in Chapter 6.

The participants acknowledge that many farmers will invent and adapt artefacts for their own use, yet describe ways in which farmer-inventors are different to other farmers, in that they are committed, methodical, talented, unafraid of change, and willing to risk critical feedback by

submitting inventions to the public gaze. Next, we consider the farmer-inventors' approach to learning.

5.5.2 Acquiring Knowledge and Skills

The farmer-inventors use both formal and informal methods to acquire the knowledge and skills, or embodied cultural capital, they put to use in their inventing. With regard to formal education, all participants left school without qualifications, by the age of 16. One went on to do a three year farming apprenticeship and a further Master Farmer's qualification in his native Germany. Consistent with the intergenerational focus discussed above, the farmer-inventors acknowledge the influence of their parents on their learning:

"I grew up with a lot of farmers who actually were illiterate ... my father was illiterate... I was always reading ... My mother, when I was ten years old ... she got the paper for me every day" (Declan)

"My father ... he had lots of theories ... he was a little bit academic. He loved reading" (Kevin).

Most have attended agricultural training, in the form of short courses and farm visits arranged by AKIS organisations, yet they are largely self-taught: *"you've a teenager that learned how to weld inside in their own workshop with no qualifications in engineering skills"* (Mark). Welding is a skill most have acquired through repeated practice, which also brings a certain amount of wastage and risk:

"I was welding, welding, and didn't know what I was at. I could weld alright, but the amount of rods that I'd waste doing the job was, because I didn't know how to cut a piece of iron, how to blend them to fit together tightly, so I'd leave gaps between and it took more rods to fill the weld up" (Francis)

"I don't have a qualification in anything ... I just do it ... I bought my first welder, they were unheard of, when I was 18. And, I remember, ... we had an old house, very old

electricity and old wiring, ... but again everyone was convinced I'd burn the house down [Laughs] so, I used to do it at the front door of the house" (Kevin).

Learning from mistakes is also linked to improving one's skills for practical problem solving:

"you're getting better in time, you do less and less trial and error. You find out that that will work, and that is long enough or not long enough, and things like that. That is, you go as you learn, but still make mistakes. It's not a problem, you can always weld another piece on and cut it with the angle grinder and heat it and bend it in a different way, there's always ways. Nothing is final in that respect, no, and thank God it will never be" (Alan)

"you pick it up bit by bit and you learn, and then you take machines apart, and you break stuff, and you fix it and ... you get a great feel of what will work and what won't work ... you just pick it up as you go" (Kevin).

The farmer-inventors seek out opportunities in social contexts to gain knowledge and skills through observation and imitation of local skilled workers, such as blacksmiths (Declan) and mechanics (Alan):

"One good thing I learned from my father, he always said 'steal with your eyes', yes, you look over people's shoulders. When he brought that tractor for servicing in the garage, I had to go with him, even if it was a school day. I begged, I threw a tantrum, I wanted to go to the garage. And the guys in the garage ... threw spanners at me at times, 'Go away, you and your questions!' I asked all the time and learned that way".

Some of the farmer-inventors regret their limited educational opportunities:

"I was sorry that I never got lessons in the art of doing these things. It's an awful loss to a person if you don't go to a professional or go to someone that can teach you how to do the thing. ... Because, you might learn a lot yourself, but you can be taught a lot from other people" (Francis)

"I would have loved to go to higher education and do engineering, I would have loved it"

(Alan).

Another prefers to use others' expertise, arguing that formal training might limit his inventing potential: *"I was going to a professional ... no point in I doing engineering because ... I could finish up with an invention that had nothing in the world to do with engineering"* (Declan). One farmer-inventor draws a distinction between the technological capabilities of 'real' inventors and Irish farmer-inventors:

"I see on the television how the real inventors do it, and it's all modelled on computers and 3-D and the whole lot, and it's cut out on machines, and everything is fine. Whether that happens in real life, I don't know... But I know in...rural Ireland, it's a lot of... mistakes and a lot of trying again" (Mark).

They are also conscious that their tacit knowledge is not as well regarded as scientific knowledge or formal qualifications. The farmer-inventors are largely self-taught and are keen to pass on their knowledge and skills, yet they are aware that the type of skills and farming practices required are changing. One is concerned at the loss of skills resulting from the increase in specialist subcontracting, what he calls *"telephone farming"* (Mark), while one of the key informants puts forward differences in skills between the generations of farmer-inventors, suggesting that:

"farmers' sons and daughters ... they're seeing their mums and dads dealing with issues of cross-compliance and paperwork ... and [are] building software packages that enable ... better utilisation of a farmer's time...eliminating the paper and making it easier" (KI 2).

The findings in regard to the sharing of knowledge and skills are discussed in the next chapter. In the section following, the participants describe their experience of taking their inventions into the public arena.

5.5.3 The Social Repercussions of Inventing

Farmers' knowledge, skills, and practices comprise part of their embodied cultural capital, which, in the form of the invention artefact, is exposed to the critical gaze of others through two main routes: on-farm demonstration of the invention to neighbours and friends and invention competitions at agricultural shows. This kind of display is presented here as a type of *"roadside farming"* (Burton, 2004, p. 203) which can gain the farmer-inventor peer recognition, by legitimising embodied cultural capital and elevating it to symbolic capital or esteem. This in turn builds social capital between farmers with similar levels of embodied cultural capital (Sutherland and Burton, 2011, p. 245). However, negative symbolic capital arises from culturally inappropriate behaviour and those who disrupt social norms may be stigmatised (Power, 1999, p. 51). Women farmers' inventions can often be hidden or disregarded (KI 1, KI 2). Validation from formal organisations bestows institutionalised cultural capital on the farmer-inventor and the findings relating to this are discussed in the next chapter.

In relation to on-farm demonstrations, the farmer-inventors describe peer responses that range from the scornful to the useful. Some invite feedback during the invention development process and will act upon suggestions and, in such cases, criticism is seen as a learning opportunity:

"we've made plenty things that haven't worked, and ... friends of mine will have seen them and they'd say ... 'that won't work' and they'll give us all the reasons why it wouldn't and we'd say, 'yeah, you're right, you're right' and you bin it" (Mark).

"you say 'right, well he said something about that, passed some remark about cutting this or changing that'. It would only register after a while that, so I thought to myself, 'well, you live and you learn' ... there's always a better way of doing a thing, no matter what. There's nothing concrete about anything, you can do it better" (Francis).

On the other hand, when the farmer-inventors receive derisory responses from neighbours they are not put off their inventing activities. However, it does affect how they approach the design

process, with one reduced to testing his turf-turning machine in the bog at night to escape scrutiny:

“People laughed at me, said ‘you couldn’t do it’, but I persevered... we used to go down in the evening, late in the evening, in case people would say ‘this fellah is going nuts or something’ [Laughs]. But I persevered and I worked, I got it going to the state that it would turn a plot of turf in half an hour” (Francis).

The key informants describe occasions during farm walks when the host farmer does not draw attention to their inventions and waits until the visiting farmers ask about them before entering into discussion. This suggests a strategy of reticence until the visiting farmer has shown appreciation of the invention and, by implication, their similar level of embodied cultural capital (KI 4).

Despite the criticism, a working invention can bring about a change of attitude in the neighbours to the extent that they ask to borrow the machine: *“Everyone would be laughing at me, saying ‘What the fuck are you at?’ But when it goes out and works, there’d be a sort of surprise then... ‘Yeah, yeah, we’ll borrow that’” (Kevin).* Local feedback is important to the development of an invention, but it is often very undermining in the initial stages, nevertheless some farmer-inventors are willing to take it to the next level and enter their ideas in public invention competitions.

Two of the three national level competitions in Ireland are based at agricultural shows: the Tullamore Show and the Ploughing Championships. All of the participants attend the shows, but not all compete. One participant, a veteran prize winner, finds the shows provide an outlet for farmer-inventors: *“there’s people have ideas out there ... and they haven’t maybe the courage to put it out ... until Tullamore started, with giving the people this chance of showing their items in the show” (Francis).* Those farmer-inventors who do not enter the competitions, have mixed views as to their relevance. One finds it useful: *“I go to them all, and I go to the Ploughing, and I*

look at them and do discuss with some of them” (Kevin). Another feels the competitions are too commercially focussed and his inventions would not fit in:

“I felt there was nothing novel enough and good enough ... these people have commercialising it in mind, and ... they have it there to find a potential technical company may be interested ... I never had anything which might have satisfied the demands for such a thing” (Alan).

Alan, however, is willing to display his knowledge and skills through the media, a form of institutionalised cultural capital, and has appeared on Irish television. For those who enjoy the agricultural shows, it is more than an annual ritual. One farmer-inventor has taken part in the Tullamore show since 1995:

“I always try to have something in it. I feel I am lost if I have nothing to go into the Tullamore show [Laughs] ... the thrill of meeting other people ... seeing all the different things that have evolved over the year, from one year to another, is something else... I haven’t missed one of them” (Francis).

Display of the invention artefact at an agricultural show, as at the farm level, brings both positive and negative responses. The farmer-inventors welcome constructive feedback and have different ways of dealing with unwarranted criticism in that environment:

“that’s the harsh reality of it, if you’re out there you’re just going to have to take the licking, just as well as the kicking ... that’s just part of the game ... we find that the guy that’ll come and find fault, and if there is fault, and if they can show us where there is fault that we were unaware of, we’ll class that as educational. I can learn from that, but I can’t learn from a guy coming along just having cheap shots, and ... for that reason we just wouldn’t entertain him” (Mark)

“you wouldn’t ... cut them off and say, unless you were sure that the thing was going to work. But if you weren’t, well, you couldn’t say it was negative ... But if you knew that it

would work ... you wouldn't hurt their feelings ... by saying 'What the hell do you know?'"

(Francis).

While some are experienced at dealing with public criticism, other farmer-inventors find it very difficult to deal with: *"I've mates that ... it would really bother them ... I know one ... there was an emotional side of him ... It got inside his head. Sure, the boys thought it was great craic to be picking at him"* (Mark). The annual nature of the event means that the farmer-inventors and interested others monitor the progress of the various inventions year to year, and thus the mocking can become an annual event too, putting some off from entering the competition:

"You go to the show and you show your product, and the next year you are walking around the show and ... you're not showing anything, and there's fellahs, 'Sure, that was a stupid idea anyway' ... and a lot of fellahs won't show the product because of that, because the ridicule will stay on... If the product is on the innovation stand this year, it should be on a trade stand next year, if right was right, and if that doesn't happen, then it's a case of 'Oh, sure, it's a failure'" (Mark).

The key informants acknowledged that lack of family support and community norms can also place limits on farmer-inventors to the extent that inventions are not developed, made public, or commercialised (KI 3, KI 5). As discussed in Chapter 4, the magazine editor suggests that submitting inventions to print or online media, sometimes anonymously, might be a route to cultural capital in such cases (Donovan, 2014).

We saw above that farmer-inventors persevere, despite setbacks, with the trial and error of the invention process. They explain why they persist when faced with public derision from neighbours or at the agricultural shows:

"I get a kick out of people looking at it and saying 'Well, you weren't so bad after' [Laughs]" (Kevin)

“They like to be acknowledged for what they’ve done ... I’m one of these fellahs that ... when a guy buys my product, when a neighbour buys the product, it’s enough for me, because ... it’s very hard always to sell on your own doorstep ... other friends I’d have ... they like this clap on the back, and ‘Fair play to you’, and the bravado that follows ... I think that drives them on” (Mark).

The farmer-inventors get pleasure from proving their detractors wrong and more so in receiving some form of public acknowledgement of their achievement. This could be in the form of, either, symbolic capital (peer approval) or institutionalised cultural capital (e.g. a show prize, discussed in Chapter 6). The farmer-inventors do not overly analyse their peers’ begrudgery, but one puts it down to envy, a trait discussed in Chapter 2: *“inventor’s jealousy, I call it, ... when I come up with things ... more often than not, instead of somebody saying ‘Jesus, that’s mighty’, ‘Jesus, that’s great’, ... they can’t do it, they say ‘Ah’”* (Declan). The key informants also recognise the mocking behaviour and some characterise it as a response to a perception that the farmer-inventors are setting themselves apart from or above their peers:

“rural people generally won’t let you get too far ahead of yourself” (KI 4)

“they’re a bit above their station” (KI 3).

One key informant suggests it is linked to the good farming criteria, as applied by other farmers (Burton et al., 2008, p. 22; Vanclay et al., 1998, p. 117), relating to a farmer’s farming focus and diligence:

“they would say ‘Well, it’s easy for him to do it, because he doesn’t work hard on the farm’ or whatever, ‘He was always at that’ ... it would very much depend ... ‘Well, he did it, he’s a good farmer, he’s a good guy’” (KI 4).

Another key informant contends the mockery is in fact clumsily expressed but well-intentioned feedback: *“They mean well and say ‘Lookit, that wouldn’t work’, what they mean is, what they’re*

trying to say is, 'Oh, do you know, that wouldn't work great, but if it was done this way, it would work better'" (KI 5).

Whatever the intention of the mocking behaviour, the farmer-inventors also find that the agricultural show judging process can be nerve-wracking: *"the show is an intimidating place... for all the world, you're displaying your baking ... the judges cut the cake open in front of a crowd, and that's it, you're there for either awe or ridicule"* (Mark).

Public displays of knowledge and skills, in the form of the invention artefact, are an important way for farmer-inventors to get feedback on and validation for their inventions. This behaviour is not always seen as culturally appropriate by other farmers, many of whom will have invented something useful on their own farms. This can result in harsh criticism of the invention, which may on occasion be valid, yet the farmer-inventors generally deem it to be unjustified. Despite this begrudgery, the farmer-inventors persevere with exhibiting their inventions; it is not clear if this is related to their community roles described at section 5.3.1 above. It is worth mentioning here that the author observed, during the extended field work period and on previous visits, that it is socially and culturally acceptable in Ireland for farmers to display their embodied cultural capital in activities such as music, singing, dancing, sports, local history, and heritage farming. The focus of hostility on farming practices that are not culturally recognised or appreciated, such as organic farming and inventing, is discussed further in Chapter 7.

5.6 Conclusion

In this chapter I have contributed to the research aim of this thesis by providing evidence to support the view that farmer-inventors are influenced by their habitus, i.e. values, and embodied cultural capital, i.e. emotions (RSQ3), as well as the economic motivators that direct their inventing (RSQ3). I also provide evidence on the farmer-inventors' entrepreneurial intentions and the difficulties experienced in commercialisation of their inventions (RSQ3), as well as the acquisition, through social learning, and the exhibition, in the form of the invention artefact, of their knowledge and skills (RSQ2) and the, often, negative response of other farmers to those

inventions (RSQ3). In the next chapter, I present further interview data in relation to the social and symbolic capitals at work in the farmer-inventors' networks, as well as institutionalised cultural capital derived in relationship with the formal organisations in the Agricultural Knowledge and Innovation System.

Chapter 6: Farmer-Inventors' Learning Networks

6.1 Introduction

In this chapter, I present the data in the same way as in Chapter 5 and start by considering three areas of findings relating to research sub-question 5 (RSQ5): 'To what extent do the ties between farmer-inventors and their informal networks represent a social learning network?' as it applies to the following three aspects of farmer-inventors' knowledge networks:

- the structure and membership of farmer-inventors' social learning networks. I find that, outside their families, farmer-inventors' networks comprise neighbours, trusted friends, and others of similar knowledge and skills and shared values. These networks operate locally, nationally, and internationally;
- sharing, or social capital exchanges. I find that knowledge, ideas, inventions, and feedback are shared within the farmer-inventors' networks;
- the farmer-inventors' view of the copying and free sharing of inventions. I find that the farmer-inventors take different views on free sharing, unauthorised copying of inventions, their own and others', and that those views are coloured by the commercialisation potential of an idea.

Next, I present the findings for research sub-question 6 (RSQ6): 'What is the state of the farmer-inventors' relationship with the formal organisations in the Irish Agricultural Knowledge and Innovation System?' (AKIS), as it relates to the farmer-inventors' attitude towards formal validation of their inventions. I find that patents and agricultural show prizes are important sources of institutionalised cultural capital, yet the process is not always straightforward. The farmer-inventors are also conscious of the knowledge hierarchy that places scientific knowledge above their tacit expertise.

I go on to look at the findings relating to RSQ6 as it relates to the farmer-inventors' perspective of their interactions with formal AKIS organisations in connection with their daily farming needs.

I find that while some of the farmer-inventors have actively sought advice and taken part in

extension activities, overall they are critical and sceptical of agricultural advice, research, and regulatory bodies. They are also concerned about the impact of national and EU policy on their prospects in a global market. Next, I look at the findings relating to RSQ6 in respect of the farmer-inventors' perspective of their interactions with formal AKIS organisations in connection with their inventing activities. I find that the farmer-inventors seek help to commercialise their inventions but appropriate support, guidance and leadership is missing. They draw attention to shortcomings in the structure, functions, and services offered by the AKIS actors, as well as the organisational cultures that do not seem to take them seriously.

Finally, I consider how the farmer-inventors describe their approach to the invention processes and its resemblance to the Double Diamond design framework (RSQ2). I find that the farmer-inventors follow, informally and recognisably, the phases of knowledge divergence and convergence in the model, yet, unlike many firms, they collaborate with others in their knowledge networks throughout the design of a new product – a feature of user innovation. We now turn to a discussion of how farmer-inventors connect with others in their networks.

6.2 Farmer-Inventors' Learning Networks and the Free Sharing of Inventions

6.2.1 Network Membership

We saw above that farmer-inventors build social capital with those with similar levels of knowledge and skills at different stages of the invention process. Here, the farmer-inventors describe some of the people they have in their close networks, beyond their immediate family, and the qualities of those relationships. Starting at the local level, one describes relationships between neighbours in earlier times:

“at night time the neighbours would come in to rambling³ and we made millions sitting at the fire. We hadn't a penny, but we were always saying how to make money ... the

³ Visiting, socialising

generosity of people, both physically helping people or if you were short of anything ...

They were there to help and you hadn't to ask them" (Francis).

Francis regrets the loss of socialising with and mutual aid from neighbours, yet another is reluctant to share his machinery with those neighbours who will not look after it well: *"similar equipment by another guy has been going around and was ruined in time ... but this particular one, I didn't want anyone to use. I welded the A-frame ... 'Sorry, you can't take it: have you A-frame?' 'No' [Laughs]" (Alan).* Similar changes in neighbour relations are discussed in Sutherland and Burton's (2011, p. 245) study of Scottish farmers and, notwithstanding the changes in rural social arrangements, one farmer-inventor describes the attributes of his close confidantes:

"good farming friends' would be guys that would come in and tell me, on my own farm, where I could improve things, and they would be doing it for my betterment, rather than just doing it for the sake of doing it ... I would do the same with them ... There'd be no holds barred, it would be laid on thick and fast by both ... but you know that there's ... no malice or no jealousy" (Mark).

We saw above that criticism from fellow farmers is often far from constructive and Mark finds that it is the intent behind, rather than the robust delivery of, the reciprocal criticism that builds trust with his farming friends. Shared values form the bonds for another farmer-inventor with:

"people who think differently and live differently ... the most interesting one is also a farmer, an organic farmer ... he is my best friend in Ireland. We can really talk about everything, we support each other, we work a little together occasionally, but he's a little bit too far away" (Alan).

Alan acknowledges the difficulty that the dispersed nature of farming presents for face-to-face connections, while another forms a connection with a local person who has skills he lacks: *"our local forge here was a very good man, and he was very versatile ... I was always going to him to fix my machines ... we had a great relationship" (Declan).* Despite the dispersed nature of farming, the farmer-inventors are often aware of other farmer-inventors in their area, which may

extend to “10-12 miles” away (Francis). Beyond the local level, the main venue for connecting with other farmer-inventors is at the agricultural shows. The competitive aspect of inventing means that the connections are not always straightforward (see sub-section 6.2.3 below), and those farmer-inventors who are not connected to other farmer-inventors acknowledge their isolation: *“I could do anything and nobody would even notice”* (Alan).

The agricultural shows are also an opportunity to meet other like-minded farmers, those who demonstrate similar levels of embodied cultural capital but who are not exhibiting inventions:

“there are some farmers ... they are farming enthusiasts, they are always at the shows to see what is new, and they want to know all about it. So, [XX] had been one of my friends back from the days of... you get to know the fellahs that are very keen” (Declan).

The agricultural show is an occasion for the farmer-inventors to interact with the public: answering questions, getting comments and feedback, which are not always positive, and sometimes negotiating sales. This is an opportunity for them to demonstrate their knowledge and skills (beyond that embodied in the invention artefact), and social status to the wider public. In the following exchange the interviewer has told Declan that she saw him demonstrating his invention at an agricultural show and he looks for feedback on his performance:

“Participant: But you still remember me talking?”

Interviewer: Oh I do, I do.

Participant: OK. Were you impressed with this fellah selling his wares?

Interviewer: Yeah, like I said, I thought you were very eloquent ...

Participant: Did you now? ...

Interviewer: They were all listening to you and that was the main thing.

Participant: Oh, yes, I could captivate a crowd” (Declan).

Presenting an invention to the public is an important way to claim their farmer-inventor identity through a skilful performance of their inventing-related skills (in this case sales) to an audience of their peers. We have seen that the farmer-inventors connect with friends, neighbours, other farmer-inventors, and interested others, through trust, shared values, reciprocal aid, interest in new ideas, and addressing skills gaps. However, there are occasions when making a connection is not desirable; one farmer-inventor applies a comprehensive range of good farming criteria to customers wanting to buy his invention:

“if the gates were closed ... and if the gate was tied with a piece of rope ... and then as I went down along the lane, I’d go thump into potholes ... then I got down into the yard ... and find that the dwelling house wouldn’t be very well painted ... the guy would take me out into the shed where he was going to put in the calf feeder ... and the whole place would be in that much muck in it, and there’d be that much muck in the yard ... I’d say ‘Listen, I’ll be around again there some day next week’ ... I’d get out of that yard, I’d go down, tie the gate, never go back. Why so? If I put in a calf feeder there, guaranteed that feeder would not be washed ... I picked my customers eventually ... we finished up going into all the places with a nice entrance gate and everything perfect, and that’s where the good farming started, was at the road gate coming in” (Declan).

Declan is conscious that misuse of his calf feeder could damage his reputation and he judges potential customers by his standards of good farming practices in a form of “roadside farming” (Burton, 2004, p. 203). Once formed, the strength of the ties between the farmer-inventors and their networks depends, amongst other factors, on the proximity of the actors as the distributed nature of farming means that making and maintaining connections can be difficult.

Although this section has focused on the farmer-inventors’ networks outside the immediate family, it is worth mentioning that all the participants mentioned family connections, in Ireland and abroad, who were successful inventors, or working in academia and politics at a senior level. In this way, the farmer-inventors drew attention to their family cultural capital assets and

demonstrated their understanding of the knowledge hierarchy. In the next section we look at how the reciprocal exchanges between farmer-inventors' and others operate, in terms of how the contact is effected and what is exchanged.

6.2.2 Sharing in Farmer-Inventors' Networks

Sharing of knowledge and information with those of similar embodied cultural capital is a feature of farmer-inventors' networks, involving reciprocal exchange, trust, and respect. This accords with Bourdieu's description of social capital as the social relationship that allows an individual access to another's resources, as well as the resources themselves (Portes, 1998, p. 3), i.e. an indirect route to economic capital. In the case of farmer-inventors the resources might include ideas, information, or skills. These kinds of networks are also known as social learning networks, which may be more or less organised and interconnected, formal or informal, open or closed to new members, and operate over different scales (Wenger, 2010, p. 6). We saw in Chapter 2 and sub-section 5.5.1 above that membership of a network, evidenced by shared practices, contributes to identity formation (Wenger, 1998, p. 149) and the recognition of shared practices between farmer-inventors is suggested here to be a form of identity.

An individual may belong to a number of networks and, in Irish rural areas, formal and informal groups may be found relating to sport, religion, and farmers' organisations. One farmer-inventor chooses not to join these kinds of local networks: *"I'm not a member of IFA [Irish Farmers' Association], I don't go to Mass, I'm not in GAA [Gaelic Athletic Association], I'm not going to the pub ..."* (Alan). We saw in the previous section that farmer-inventors often connect with like-minded farmers, and one recalls the sharing of a story of a new type of technology: *"a neighbour of mine went to buy an old mowing machine from a farmer ... I can still remember the day he came back ... he said 'I saw the most amazing thing ... that I ever saw in my life'"* (Declan). This sharing of new ideas connects Declan and his neighbour, while the sharing of experience gained in the developing of ideas is another way of building a local network:

“he tells you ... ‘Tom down the road done something like that, you should call over to him’, ... you go over to Tom and you get, maybe, an idea off of him, and he tells you then about Mick down the road that did something else similar. You finish up that you do a bit of networking” (Mark).

Another talks about receiving advice on marketing from *“a woman, who is a great friend of mine”* (Declan) that led him to build his mechanical cow: *“she says ‘... If the system is working ... you’re able to feed cow’s milk warm without problems ... that’s the same as the cow. So what you’ll do ... is make up a cow’”* (Declan). Farmer-inventors’ networks also extend beyond the local, with agricultural shows an important space for connecting with other farmer-inventors.

One participant has built connections with other farmer-inventors across Ireland over many years of entering competitions and finds that, over time, the group membership has changed: *“It’s amazing from the first time I met them, the number of people that came and went ... from ‘96 on, a lot of them have went by the wayside”* (Francis). Another sees the quality of ideas wax and wane also: *“I’ve seen going to the shows, years after years ... the same guys ... they come up with some daft and then they come up with some very good ideas”* (Mark); one key informant describes these frequent competition entrants as *“serial inventors”* (KI 1). Some participants also share business contacts with fellow farmer-inventors (Mark), while another is active in a growing network relating to sustainable building methods (Alan).

We saw in Chapter 5 that maintaining interest in an invention through its development stages requires perseverance and the participants will offer encouragement, in the form of positive feedback, to fellow farmer-inventors at the shows: *“we’ve come to the conclusion that if you don’t agree with what some fellah is doing, just walk away from it. And if you do ... encourage him or ... admire what he has done”* (Mark). However, another is willing to challenge what he considers to be poor business practice by a fellow inventor: *“I reckon that was horrible profiteering; I said it to the man as well. I said, ‘...technology is relatively cheap ... you just put*

that price because you reckon that that's what the market can bear', and I didn't think that was fair" (Kevin).

For those who have commercialised their ideas, there are benefits in the word-of-mouth nature of farmers' networks, as seen in this story recounted to Declan by a sales agent for his product:

"he [agent for selling the calf feeder] said 'This man, who was using my machine, ... is getting the best price every Monday for his calves at Bandon Mart' ... West Cork farmers are great men for exchanging new things and better ways of doing things ... When they see [XX] getting these great prices, they ask him 'How did he feed his calves' and [XX] would answer 'The [XX] Feeder', which was my feeder" (Declan).

Apart from the sharing of good practice between farmers, there are also more formal networks, in this case for organic farming, with one farmer-inventor involved in setting the criteria for membership: *"the Irish organics standards were written actually at our kitchen table ... we were really leading the field with other people ... and we got funds from the [UK] Soil Association ... They brought their standards and we were the first Irish standards"* (Alan). Another farmer-inventor talked of the American National Inventors Hall of Fame and suggested a similar organisation in Ireland would be helpful in that *"people can communicate together ... the philosophy'll spread"* (Francis), while another called for farmer-inventors to be invited to take more formal roles in the evaluation of inventions, for example as competition judges (Mark). Connections with other networks of like-minded people is a feature of communities of practice and could also be considered a form of social innovation.

In this section so far, we have seen that farmers exchange stories, ideas, and feedback, and some form themselves into more organised groups with common purpose. We now consider the sharing of skills through social learning, what one describes as *"trying to educate uneducated farmers"* (Declan). One gives informal welding instruction to neighbours:

"I did do a bit of welding for the neighbours around here and they used to come in ... I'd give them a bit of iron 'Weld that and try it' ... they didn't know how simple it was ... It's

amazing the number who got into welders after, just because they were shown how"

(Francis).

Another continued to work with apprentices after moving to Ireland from Germany, and found it to be mutually beneficial:

"It is great satisfaction to teach somebody and see them improving ... 'OK, you do it, because when I'm telling you it's not working, you won't believe me'. But when you make your own mistakes, you learn ... I learned so much from apprentices ... it was a very two-way thing" (Alan).

One suggests that seeing the inventions at an agricultural show can inspire farmers with new ways in which they might deploy their skills:

"An awful lot of people have learned by coming and looking at things. They went home and were able to, say 'Right, we'll get a welder and we'll be able to mend an old tractor, mend an old fork ... mend something with it'. There's no doubt, this Tullamore Show was a great help to people making things" (Francis).

The farmer-inventors' informal networks described here operate locally and nationally, at agricultural shows, while more formal networks also exist. They involve the enthusiastic sharing of knowledge, skills, and ideas, as well as the giving of feedback; however, the free sharing of inventions is not universally embraced.

6.2.3 Free Sharing and Copying of Inventions

We saw above that farmer-inventors are willing to share knowledge and ideas in the networks to which they belong while, in Chapter 4, most of the inventions sampled were freely shared through the magazine network, as suggested by the user innovation literature (von Hippel, 2007, p. 294). Yet, in Chapter 5, we saw that all the farmer-inventors had considered protecting their Intellectual Property, a precursor to taking their inventions to the market. In this section I present

the interview findings as they relate to the free sharing of the completed inventions, as well as the copying of inventions.

Farmer-inventors' attitudes to the free sharing of completed inventions within their networks range from complete openness to limited sharing of minor or non-market products. One farmer-inventor, a contributor to Practical Farm Ideas magazine, is clear when asked about commercialisation of his inventions that he preferred the communal benefits that reciprocal sharing might bring: *"Why shouldn't I share? I love other people sharing things with me too ... we have to share much more ... community helping each other, supporting each other, it's the only way forward"* (Alan).

Another farmer-inventor takes the view that acting upon an original idea and getting the benefits from the first use of the product is more important than the loss of economic returns when an idea is shared: *"your idea in your head is no good but if you put your idea out there first ... then you've had the first of it"* (Francis). For another getting his invention into wider circulation brings greater satisfaction than financial gain: *"I don't want to make money out of it and I'd be so thrilled ... if I could give that idea to somebody and say 'do that', and all I'd want them to say is '... [Kevin] gave me that idea' ... I'd love it to be out there and I'd love it to be working"* (Kevin).

The farmer-inventors who state their willingness to share freely also acknowledge the reciprocal expectation and peer recognition that arise from such an act. Those farmer-inventors with experience of commercialisation are willing to share some of their ideas, but not all: *"we'd have ideas where my mates'd use them and we wouldn't be selling them to them, because they'd be too simple an idea to sell on, they could just go in and make it themselves"* (Mark). The sharing of minor products might well increase the farmer-inventors' reputation locally, a form of symbolic capital, but one farmer-inventor is cautious about too much information about early stage ideas getting into the public domain:

"There would be always little things going on in my mind that I wouldn't mention to anyone, because if I start talking about this now, this fellah will run away with it, and he'd be only mouthing about it..."

Interviewer: OK, so you keep it to yourself for a while?

Participant: ... I would, yeah" (Declan).

Similarly, another has a group that he will share all his ideas with, but it is a select group:

"Participant: You tell your mate the way you did it, and he tells you 'oh, this is the way I do it', and maybe his way is better ... or maybe your way is better ... It's up for debate then as to ... which idea is best

Interviewer: So you do talk to each other about your ideas?

Participant: oh, we would, yeah

Interviewer: All your ideas or just some of them?

Participant: ... depending on who we are talking to, but as a rule we would, yeah" (Mark).

The fear of ideas being spoken about publicly or being copied is an issue for those farmer-inventors considering taking the idea to the market, and is also acknowledged by those who are willing to share their ideas: *"if I was involved ... in manufacturing ... and I had an idea, well, I wouldn't divulge it then, because it would be ... my financial angle"* (Francis). However, one key informant, from an innovation support organisation, suggests that too much secrecy might be counter-productive: *"a lot of the times you actually do need to talk to customers ... you might put a rough prototype in front of potential customers, but you do need customer feedback before you have a final product"* (KI 2).

Although the farmer-inventors understand the need to protect their Intellectual Property, they have mixed views on the copying of their ideas. Some accept it as inevitable:

"I don't give a damn who copies my stuff ... the same idea develops at the same time in lots of cases, because, obviously, the same need is there ..." (Kevin)

"a few people come in and at the time ... they'd be only looking for ... an idea ... to make it themselves, which is understandable, isn't it?" (Francis).

One suggests that copying might improve an idea as more people's expertise is brought to bear:

"you could incorporate someone else's idea into an idea on that, because they maybe have never cross-referenced one another" (Kevin). The farmer-inventors will also copy others' ideas, some

for personal use: *"I do it myself [laughs], if I saw something that was going to be helpful to me"*

(Francis). Another, who is careful not to let his ideas be copied (see above), has copied ideas in

the past in order to manufacture them himself: *"I was the one that went to the shows and ... we*

... copied lots of inventions ... things for scraping muck and things like that, for the tractor"

(Declan). One of the key informants makes a similar point, suggesting that farmers attending

shows will copy ideas they have seen because they have the knowledge and skills to do so:

"There's a huge desire to go along and see what's new, and then go home and pull out the welder and do it myself, because 'I can do that better, it didn't cost him that much to make it, ah, it was a lot easier than what he said it was'" (KI 2).

However, one farmer-inventor views copying as an unfair appropriation of ideas and describes an incident at an agricultural show:

"one farmer ... was putting the measuring tape up against it and he taking pictures ... he was going to be making them when he went home and you knew by him that he wasn't going to be making it just for himself ... he was just copying some other fellah's idea and just going off making a business out of it" (Mark).

This kind of blatant copying is not restricted to other farmers, Mark also alleges copying of inventions exhibited at agricultural shows by big agricultural machinery manufacturers. The ease with which patents can be breached, for example through minor changes to the design, leads him to view patents to be *"an absolute waste of money"* (Mark), because protecting a patent

involves High Court action which is beyond most farmers' means: *"The Patents Office get paid every time there's a patent ... the solicitors ... they're only hoping that there'll be litigation, because if there is, there's more money for them to make"* (Mark).

One farmer-inventor welcomes defensive publication (Strumsky and Lobo, 2015, p. 1447) as a subversive act of sharing for the greater good: *"if you publish it once, nobody else can patent it ... That is the good thing and there is some philanthropist there who, for that sole reason, put things out on the web, and in webpages, on Facebook, so that everyone can copy it"* (Alan). This kind of information is seen in Practical Farm Ideas magazine, as well as websites such as Farm Hack, although defensive publication may not be the intention. It is also a route to institutionalised cultural capital and symbolic capital for the farmer-inventors within that milieu. The participants understand the need to protect their Intellectual Property if they are to market their idea, yet they seem to take contradictory positions on the copying of inventions in that they seek to guard their own ideas as much as possible, while simultaneously being willing to copy others' ideas. The agricultural shows are not just an opportunity to exhibit an invention or source new ideas, the winning of a prize provides the farmer-inventor with institutionalised cultural capital, which we consider in the next section.

6.3 Farmer-Inventors' Relationships with the Agricultural Knowledge and Innovation System

The formal organisations involved in generating and disseminating knowledge and supporting innovation in Irish agriculture are conceptualised as an Agricultural Knowledge and Innovation System (AKIS) (Prager and Thomson, 2014, p. 7). The relevant actors for this part are: public sector (local/national government and agencies, e.g. Teagasc, Enterprise Ireland); education and research (universities, Teagasc); agricultural extension (e.g. Teagasc, regulators); private sector (e.g. banks, co-operatives, input suppliers, media, food chain); and farm based organisations (FBO) (e.g. Irish Farmers' Association, Macra na Feirme for young farmers, Irish Organic Farmers and Growers Association).

6.3.1 Seeking Validation from Formal Organisations

The sharing of tacit knowledge is common in the farmer-inventors' networks and can be a source of social and symbolic capitals. Taking an invention, the embodiment of knowledge and skills, into the public gaze brings the potential for gaining validation from formal organisations, considered here in the form of patents and competition prizes. This can also increase social status within the social capital network of like-minded farmers and interested others. However, the farmer-inventors' tacit knowledge is not always valued by other farmers or the formal AKIS organisations.

First, looking at patents, two of the farmer-inventors have patents, and for one it confers legitimacy: *"I have a patent from the British Patents Office for that machine, so I can legally call myself an inventor"* (Declan), as well as marking him out from other farmers as someone to be taken seriously: *"put me down as being something of a rare breed ... the fact that I have the patent ... gives me proof that I'm just not a bluffer"* (Declan).

Second, with regard to invention competitions, all of the three participants who are regular agricultural show entrants have won prizes (Francis, Declan, Mark), generally a trophy, a sum of money or, in the case of county contests, entrance to a national competition. For one, it encouraged him to persevere with his inventing: *"we won a prize for £250 and we thought that it was great altogether ... it just drives you on to go that little bit farther"* (Mark). Two of the farmer-inventors have featured in the media as a result of their prizes: Francis' inventions have featured in the Irish Farmers Journal, while Declan was invited to exhibit at the Royal Agricultural Show of England and featured in the BBC coverage of the event: *"only two exhibitors picked out of the Royal Show, and I was one of them. Wasn't that something?"* (Declan).

For another the social aspects of the show, the chance to meet other farmer-inventors and build social capital is as important as winning a prize (Francis). While there is prestige attached to winning, one participant suggests that, as the only opportunity for farmers to present their inventions and get feedback, it puts farmers in a difficult position: *"his hand is put behind his*

back, because you either bring it here and show it or ... you leave it at home gathering dust" (Mark). He goes on to suggest that farmers who lack the confidence, time, or money to attend the show may never exhibit important inventions.

Once entered into the show, the awarding of a prize follows an assessment of the invention and the farmer-inventors are somewhat critical of the judging process. One was very angry that his invention had not been examined to his satisfaction by the judges:

"I said, 'When are we judging this, my product?' ... 'We judged it', 'When did you judge it?', 'Ah, sure didn't you see us going around', 'I saw you going around ... but you didn't judge my product', 'Oh, we did, we thought it looked nice and everything'. Jaysus, I lit him⁴ ... 'This is stupid ... I have something there ... and I would need somebody that would know something about what it's about ... to sit down for at least an hour ... to go through ... what I am doing'" (Declan).

Apart from criticising the judges' approach, another farmer-inventor questions whether judges' qualifications are always relevant to the task:

"They always throw in an engineer ... Is it an electronic engineer, is it an electrical engineer, is it a technical engineer, is it a mechanical engineer, is it a service engineer? ... if you have a guy that's specialising in one thing, the product might be for something completely different" (Mark).

As well as highlighting the shortcomings of the judging process, the farmer-inventors are also aware that their tacit knowledge is not given as much weight by the *"powers that be"* (Declan) as the codified knowledge of the formally educated. They understand the limitations of their knowledge and regret the lost opportunities for fruitful interaction:

"I'm just a Joe Soap, a fellah from national school ... how can Professor whatever-his-name-is ... how can they come down to my farm, how can they come down? I mean, you

⁴ Got angry with him, tore a strip off him

go up a ladder ... you don't come down ... I am disappointed with that, because I think there is a loss there" (Declan)

"you get someone from the city that comes over to do something in East Clare, but they don't know nothing about East Clare, ... you need a certain amount of local knowledge" (Mark).

This awareness of the dominance of formal learning extends to the farmer-inventors' approach to inventing; one trusts his own judgement, which is born of experience: *"[XX] tells me that there's all sorts of stresses and strains and calculations that I should make, but I don't make them ... you have an eye for that sort of stuff ... you've an idea what strength will work"* (Kevin). The farmer-inventors' recognition of the value of practical expertise extends to a direct comparison with formal agricultural researchers:

"Teagasc lads have a different brain to me ... I have no doubt that them guys are a way better at what they're doing ... than I would be. But it is possible, because I have more contact with bits and pieces on the practical side of it, I am in a way better position [to create new products]" (Declan).

Not all farmer-inventors get it right though, one key informant, a farm adviser, gives an example of a *"negative idea"* (KI 5) that might create more problems than it solves:

"rather than dip their sheep with insecticide ... they get a power washer and they power wash [the sheep], now it's lethal ... you're making an aerosol out of the insecticide which you will inhale yourself ... OK, it might keep the flies away but you'll get resistance ... because you're ... under-treating them" (KI 5).

The superior status of formal knowledge is increasingly enshrined in policies and regulations. One farmer-inventor lost his job when his years of tacit knowledge was deemed no longer sufficient for the role: *"I worked as an Organic Inspector for five years, until the EU took over, and said everyone has to have an academic qualification to inspect farmers"* (Alan), yet his

experience shows that formal learning is not always useful to the farm apprentice: *“I thought, Jesus Christ, he was gone to university, what can I teach that guy? I learned very quickly, he knew absolutely nothing. In the field, I knew a lot”* (Alan).

In seeking validation for their inventions, the farmer-inventors recognise that their tacit knowledge gives them certain advantages over those with formal learning and the superior status of codified knowledge is thought to be unfair. Some farmer-inventors apply for patents or enter competitions, while others are more interested in peer approval. We now consider the interactions between the farmer-inventors and the formal AKIS organisations.

6.3.2 Farmer-inventors' Day to Day Interactions with AKIS Actors

In this section I set out the farmer-inventors' perspective of their interactions with formal actors in the AKIS in connection with their day to day farming needs. All of the farmer-inventors have been a member of or used the services and products of the AKIS organisations. They discuss their views, both positive and negative, in relation to advice, agricultural extension, education, research, regulation, the wider business environment, and national and international policy.

Agricultural advice is generally viewed through a sceptical lens, the farmer-inventors cite: inappropriate advice, for example regarding native cattle breeds (Alan); reversals in advice, for example in relation to tillage methods (Kevin); and advice influenced by financial interests, *“pushing chemicals”* (Kevin). This lack of trust is compounded by the financial risk carried by the farmer as a result of the advice:

“These people are not practical people, they have all the theoretical knowledge, they make your calculation, and it looks wonderful on the paper, and then one of the factors changes and the farmer is down the drain and pays the bill and carries the responsibility” (Alan).

Alan is referring to Teagasc in his comment and Teagasc features a lot in the farmers' narratives, probably because of its broad scope in providing agricultural advice, research and education, as

well as the interviewer being identified with the organisation. The advisory service acts as a knowledge “broker” (Oreszczyn et al., 2010, p. 406) between farmers and research bodies, yet the farmer-inventors have mixed views of Teagasc’s extension activities. Some have taken good ideas from farm walks and international fact-finding visits, and have themselves acted as Teagasc demonstration farms (Declan). Another found that the organic farm walks were focused on economic benefits, rather than good farming practices: *“Do you know what they were talking about? Profit. There was not one word about soil, or micro-organisms, or anything important to a real organic farmer”* (Alan).

The farmer-inventors were also wary of the vested interests involved in agricultural research (Alan, Kevin, Declan), linking research findings to the funder’s agenda, and suggesting that some research is against the farmers’ interests, e.g. Teagasc’s research into artificial meat that would compete directly with farmers’ livestock production (Alan). None of the farmer-inventors have received formal agricultural training, yet one benefited from his membership of Macra na Feirme to be trained in public speaking (Declan).

In common with many small businesses, none of the farmer-inventors have anything positive to say about regulatory organisations, such as the Department of Agriculture, Food and the Marine; Environmental Protection Agency; Bord Bia (Irish Food Board), and the Food Safety Authority. They describe a ‘tick box’ culture that, in their view, does not address important issues of quality assurance (Declan, Alan), inspectors who cannot or will not justify their requirements (Alan), general red tape and form filling (Mark, Alan, Declan), overly conservative local planning guidelines (Alan), and fines for inconsequential infringements that are considered to be good farming practice (Alan).

They are also concerned about Irish farming remaining competitive in a globalised market and discuss the power of big companies in relation to data gathering (Alan) and marketing. One gives the example of animal vaccine marketing that cites scientific studies but does not explain the facts upon which the claims are based: *“any information they have about improving the health*

of the cattle, unless there is a payback at the end of the day, why should they bother telling people?" (Declan). This withholding of information is felt to unfairly affect farmers and deprives them of the opportunity to develop alternative solutions. Obstacles put in the way of electricity micro-generation by the state Electricity Supply Board (ESB) are also mentioned (Alan, Francis). Those who have experience of the media are generally positive, except one (Alan). He is involved in a number of campaigns and finds media interviews can misrepresent his opinions on environmental matters, he was pleased to receive a copy of his interview transcript for feedback.

The farmer-inventors discuss policy at the national, and international/EU levels. One praises the farmers' Early Retirement Scheme (Mark) and suggests it be reintroduced to encourage the transfer of management on farms. The others are critical of past and ongoing policies relating to the setting up of co-operatives in Ireland (Declan) and the consequences of the EU's policies towards small family farms (Kevin) and cheap food (Kevin, Alan). One finds that overbearing political, religious, and media dogma stifles human agency: *"you take the right of the human being to be free to use his mind freely"* (Francis). In the next section we look at the farmer-inventors' experience of these organisations in relation to their inventing activities and their further dissatisfaction with the prevailing arrangements.

6.3.3 Farmers' Interactions with AKIS Actors in Relation to Their Inventions

Apart from their dealings with the AKIS organisations in relation to their quotidian farming activities, the farmer-inventors, particularly those who intend to commercialise their ideas, also interact with those organisations tasked with supporting innovation. In this section we look at these contacts (other than those involving agricultural competitions and patents which are covered above) and find further frustration. All of the farmer-inventors acknowledge that they need help to take their inventions forward as they lack some of the knowledge, skills, and resources required: *"that's why you need people with you to push things. You need someone to ... stand beside you and say 'Right, we'll go', instead of saying 'I'll go' ... we need someone's support"* (Francis). The farmer-inventors find that the support on offer does not meet their

needs: *"in real life ... there is no Dragons' Den ... if I have an idea tomorrow I can't go to Dragons' Den in Tralee and say 'I've an idea, lads, do you want to buy in?' That's not there"* (Mark). It is also difficult to find the help that does exist: *"a lot of the state bodies run their business the same way, in that if you don't know which door to knock on they are not going to make you any wiser"* (Mark) and while there are a number of local and national agencies offering support, to the farmer-inventors, they seem to have overlapping responsibilities: *"in this area ... you've four or five organisations ... they've different names but they are all ... doing the same thing"* (Mark). Further, there is also a lack of signposting and referrals between agencies: *"everyone sticks to his own patch"* (Declan), so that the farmer-inventors are not aware of alternative sources of help.

When the appropriate organisation has been found, the criteria for accessing support can exclude some farmer-inventors: *"a lot of people are slipping in between, not big enough for this and too small for that"* (Mark). Once accepted for support, the farmer-inventors, who are already running farming businesses, find the training offered to be too low level and not relevant to the production of artefacts: *"it was very basic and ... modelling it on some business ... a corner shop ... was of no real benefit to what we were at"* (Mark). Another found that there was no follow-up to the training and he was left *"to go home with literature"* (Francis) and raised expectations: *"I came home from that meeting in Thurles and I said 'I'll be a millionaire in no time'"* (Francis). Others want support that does not seem to be available: *"[if] they had come in and looked and said, 'Look [Declan], we know you're a great owl' trier ... but your invention, we can't see any merit in it' and go away, I would be happy"* (Declan). Looking for feedback on whether an invention has realistic potential in the market is understandable when significant time and money might be invested in commercialisation.

When it comes to financial support, the farmer-inventors find that grants come with conditions that seem over intrusive: *"I had a very good accountant, but he was not a chartered accountant, and, in order to draw down the 15,000, I had to move to a chartered accountant"* (Declan), and sometimes it is cheaper to DIY rather than comply with grant conditions: *"if ... you go for grants, you have to comply totally with all their rules and regulations ... I looked into building a shed with*

grants. I could build it, actually, the way I wanted it cheaper myself" (Alan). Apart from the burdens associated with grant conditions, the farmer-inventors find that financial institutions, such as banks, do not understand the seasonal nature of cash flow in farming and, for new small businesses, often require a year's trading before they will lend any money (Mark). The farmer-inventors also want help to negotiate the rules, regulations, and paperwork involved in running an enterprise (Declan, Mark), and in a way that is tailored to their business: *"[we] want to be asked 'What do you need? ... We'll give you an engineer to get it CE certified, or we'll get you an electrician to get ... a safety statement on it'"* (Mark).

As micro-entrepreneurs, the farmer-inventors are aware of the resource imbalances that exist between them and large organisations and businesses in the AKIS. One was offered a distribution deal for his invention by a large company but *"what they'd give me for making it wouldn't ... pay at all"* (Francis) and he felt a lack of negotiating power. It is not clear whether this deal resulted from a lead user process or if Francis initiated contact. Another finds the AKIS organisations to be too close to pharmaceutical companies and closed to farmer-inventors' ideas: *"the basic opinion I had of the Animal Health Ireland, it was like a meeting of drug dealers"* (Declan). One finds the costs of product testing works to the advantage of large businesses:

"it's nothing to do with the fools eating the food, they're not worried about the people eating the food ... it's to stop competition, because there's very few of us who can come along with five million tomorrow morning if we come up with a product. So, it's a way of curtail the game" (Mark).

The participants believe that the AKIS organisations do not understand the challenges they face, in that the farmer-inventor does not have in-house skills and resources, such as marketing, accounting or technical design that a manufacturing company might. Similarly, those charged with rural development are not seen to support opportunities for the small number of jobs that these types of enterprises might provide, which *"keeps the parish alive"* (Mark), or to give any priority to farming related innovation (Francis). One key informant explains this may be due to

changes in funding rules that do not target agricultural innovation (KI 5), although another acknowledges the importance of agricultural machinery manufacturers to Irish exports and regional development (KI 2).

This is further compounded by the farmer-inventors' sense that they are not taken seriously by the AKIS organisations: *"I keep making allowances for them, and I keep saying ... 'They're not coming to me because they think that I am a bit way out here'"* (Declan); one key informant (KI 3) suggests that farmers' inventions are *"little ideas"* and that farming inventions are more likely to come from engineering companies, rather than the farmers themselves, suggesting a lack of awareness of the extent of farmers' inventing. It should be pointed out that Declan has been trying for some time to get the relevant AKIS organisations to look at his clean water invention. Towards the end of our long interview, he did acknowledge that he had met with Teagasc and his dairy co-operative, but they declined to visit his farm to see the system in action: *"they invited me to Moorepark [the Teagasc dairy research centre] and I said, 'There's no point in I going to Moorepark' I said, 'because I know what's in Moorepark, I want you to come and assess my farm, and I have it set up here'"*. His expectations of the AKIS organisations are partly founded on his belief that a social capital relationship exists between them: *"Our farm has been used all down through the years and always at the disposal of Teagasc for anything they wanted ... I'm very disappointed"* (Declan). The reciprocal obligation created by the use of Declan's farm as a demonstration farm is not honoured to his satisfaction by the AKIS organisations, yet one key informant suggests that the lack of the kind of independent verification that Declan is seeking for his invention to be a shortcoming in many farmer-inventors' approach to product development:

"that's the difficulty ... you don't have the farmer coming into ... Enterprise Ireland or Teagasc and saying 'Look, I've got this idea, I want to try it independently on two farms' or going to the ... Farmers Journal test farm or the UCD farm ... and saying 'Lads, somebody road test that and come back to me when it's broken'" (KI 2).

Declan has an ongoing grievance with the AKIS organisations, yet KI 2 would seem to support the principle of his position. Declan is not the only farmer-inventor to find the AKIS organisations lacking in relation to the support offered.

Some of the farmer-inventors are also critical of the culture of the organisations, finding them to be hierarchical (Alan, Declan), *“extremely inflexible”* (Alan), out of touch (Declan), and not showing leadership to support farmer-inventors’ entrepreneurial activities (Mark). One farmer-inventor wonders whether the lack of interest in farmer-inventors is due to *“arrogance or ignorance or ... jealousy”* (Declan), as evidenced by poor basic customer service: *“Animal Health Ireland, I had been in contact with those fellahs and ... they hadn’t even replied to my letters”* (Declan). Yet they also acknowledge that individual staff in the organisations are generally helpful (Francis) and committed: *“there is absolutely no doubt they have some excellent people amongst the staff, their heart and soul is really in the right place”* (Alan). One criticises Teagasc as a self-sustaining rather than innovative system: *“once the system gets a hold of somebody in Teagasc ... they pretend to do a certain job ... and that isn’t inventing new things. It’s only looking after the system that’s in place”* (Declan). When Declan was told that Teagasc has developed innovations, using the Rooster potato as an example, he remained sceptical, suggesting that *“most of the things that are on farms have been developed by companies”*. One key informant acknowledges the difficulties faced by the farmer-inventors and suggests that cuts to public sector funding and staff has resulted in reduced capacity to deal with non-priority issues, while the help that exists is ad hoc (KI 1).

Despite seeking validation from the AKIS organisations, the farmer-inventors are unconvinced by the advice and support on offer, in connection to both their routine farming and inventing activities, and offer a detailed critique of the structure, functions and culture of the organisations. The farmer-inventors seem to relish the opportunity to contest their subordinate role in the knowledge hierarchy and alleged neglect by the authorities: *“that’s what the powers that be think of farmers ... they’re not really very worried about the farmers ... once we look after everybody else outside of the farm gate, let the farmers be fucking looking after themselves”*

(Declan). Declan has taken on an outspoken role in his community, which he has used to some effect over the years to draw attention to the difficulties faced by farmers in his area and wider. Another farmer-inventor argues that the formal organisations try to manage or close down debate, using Teagasc as an example: *“they have a website, Facebook page, which dictates everything ... they have designed it so that you have really to look ... Is there any comments? Has anyone said something? ... They don’t want to give people really a platform”* (Alan).

This willingness to challenge authority seems to support Shutes’ (2003, p. 78) theory of ‘strong’ farmers who use their cultural capital to draw attention to problems in their communities; they also have their suggestions for how things might be improved. We now look at the extent to which the farmers’ approach to inventing resembles the design process in firms.

6.4 The Farmers’ Approach to Inventing as a Design Process

In this section I present data on farmers’ approaches to inventing as it relates to the Double Diamond model which describes the design process in firms in four phases: Discover, Define, Develop, and Deliver. The user innovation process considered here occurs outside the firm and I set out, phase by phase, how the farmer-inventors’ approach follows and differs from the more formalised method.

In the opening Discover phase, the farmers respond to a need that is revealed through their own farming practice or the practice of others, a characteristic of user innovation. The increase in farmers working alone brings about the need to *“simplify doing a job, so that he can do it on his own”* (Mark). One farmer-inventor mechanised a farm task unpopular with his family: *“We’d have to turn the turf by hand, and the three girls ... didn’t like the job ... that was why I had to design some way of turning turf”* (Frances), while another proactively looks for mechanical solutions: *“Everyone else is taking the shovel and I think ‘How can I do it with the forklift or with the tractor, or something like that?’”* (Alan). One saw a new type of machine in operation on a farm and realised that it could be improved: *“I said coming home that night ‘machine feeding is on, but the machine has to be simpler’”* (Declan).

The farmer-inventors find repeated experience of a problem, a feature of user-innovation (Lüthje et al., 2005, p. 959), to be a source of ideas: *“what we do is repetitive enough. We’d do something and then we think about it after doing it and we’d say ‘Jesus, the next time I’m doing that, I’m going to do it this way’ ... as time comes along we become experts in finding the easier ways”* (Mark). One points out that a lack of user involvement in farming machinery design leads him to adapt machines to make them easier to use: *“the people designing that machine often never drove more than half an hour on the machine ... you sit six hours or eight hours on a machine and you have to repeat all these stupid movements all the time”* (Alan).

The Discover phase involves an initial idea to resolve the problem and farmer-inventors talk about where they get inspiration: *“I’d be going along the road anywhere and I’ll be looking at something to see could I get an idea, something that would give me an idea. People gave me ideas just passing a remark on something”* (Frances). One suggests another incentive: *“I don’t know where the ideas come out of ... just desperation, I suppose”* (Kevin). The farmer-inventors seek ideas for tangible solutions to self-identified farming problems from a wide range of sources: their tacit knowledge and experience, knowledge networks, and the wider context. In firms the Discover phase generally occurs in response to broader market or social trends.

In the, second, Define phase of the Double Diamond process the generation of new knowledge (or a recombination of existing knowledges) takes place to fulfil the identified need. The farmer-inventors describe how positive initial results lead them to take an idea forward: *“Once it had worked a little bit, you knew that it would work, there was something in it”* (Frances), while, in a kitchen experiment, another’s novel idea shows promise:

“I started in from scratch to make this box and get it heating [milk] ... I was using water instead of milk ... I was running it through a little box ... up on the bench in the kitchen ... then I got it – gravity - out my little tubes down to the ground ... my little machine was changing the heat of the milk from 6 degrees ... up to 37 degrees, and I was getting a continuous flow. Woo! ... I found that my machine was able to get a continuous flow of

20 gallons an hour from cold up to body temperature. Woo, boys, I got it! ... That was magic to me” (Declan).

It is clearly exciting to find that an idea works, yet not all ideas come to fruition: *“a lot of what we’d start would finish up completely different ... you’d find out halfway through that no, that won’t work, and we’ll have to rejig it and start again”* (Mark). The filtering out of unworkable ideas in user innovation often follows an informal evaluation by trusted peers: *“we’d be asking them, ‘what do they think of this?’... and they’ll say ‘yeah’, or they’ll say ‘who’ll want it’ and then they’ll say ‘no-one will want that’”* (Mark). As a result of positive feedback the farmer-inventor may decide to invest resources in further testing and research, representing a narrowing of options. In a firm this phase would involve the alignment of market needs to business objectives and we saw above that not all the farmer-inventors have entrepreneurial intentions for their ideas.

Turning to the Develop phase, this involves multiple iterations of the design to achieve a viable prototype and the farmer-inventors recognise that repeated experiments can improve their products: *“farmers are big into trial and error, and error doesn’t seem to bother us ...the trial is more important ... we know it isn’t right, but it’s better than the last time”* (Mark). Another explains the effort involved in learning about and sourcing the technical components of his invention:

“... things like thermostats, I had to learn myself about that ... I found you could buy a thermostat for a tenner ... there was a crowd in Denmark were able to give me a thermostat for 900 quid ... it would be much finer differentials ... I had to go through the grief of all that” (Declan).

The Develop phase also includes inputs from internal and external stakeholders to refine the idea. In user innovation, stakeholder input is likely to involve collaboration with other users and some farmer-inventors test the market by lending the invention to trusted friends (Kevin), while others enter invention competitions at agricultural shows (Mark, Declan, Francis). One farmer-

inventor encourages input from his son at this stage of the process: *“we disagree on the method that we use, so ... I’ll probably make up a prototype, and he won’t agree with it, and he’ll work on it”* (Kevin). The farmer-inventors’ perceived lack of support from AKIS organisations at this stage is discussed above.

The seasonal nature of farming means that testing in the Develop phase maybe spread over a number of years: *“...like the turf machine I was talking about ... the season is short for that, the turf is cut and it’s dried ... You had to wait for the next year to come around then to start again”* (Frances). However, any delay in development of a new product can be risky for the farmer-inventor:

“what he’s started ... was innovative, but the problem is that ... it’s taken too long to turn the idea into reality ... in the meantime, there’s other guys have had the same idea but they’ve brought it to market. So, he’s stuck ... he’s after pumping in all this money and it’s basically a white elephant” (Mark).

As we have seen, the farmer-inventors face social repercussions in taking their product into the public domain yet a lack of market research can also mean that they may be not be the first to launch a new product:

“We make something and we think ‘This is it, everyone wants one of these’ ... we spend loads of money on it until we realise that ... it’s of no use, or it could’ve been done different, or it was made before, 20 years ago, by some other fellah before... We hadn’t researched it ... we thought no-one else had thought of the same idea” (Mark).

The key informants point out that lack of awareness around the legal requirements for machinery can also cause problems for farmer-inventors: *“some of the rationale for not being on the market elsewhere might be because it doesn’t comply with safety requirements, it’s not going to get CE [European safety mark] certification”* (KI2). The Develop phase may also include the protection of Intellectual Property associated with the invention.

The farmer-inventors are conscious that their approach to product development may be seen as unconventional, when compared to trained engineers:

“normal people would make a drawing and I go in the workshop and take the welder out ... It’s all trial and error ... that is what engineers, when they are studying it, learning to avoid these things” (Alan).

“Most of the time what I do is, I overdesign, I over-strengthen ... if I see something, and if I’m going to improve on it, I’ll make it too strong” (Kevin).

The Develop phase brings further knowledge and information to the farmer-inventors through their own trial and error, as well as input from others. They may not have access to the resources of a firm yet they persevere to achieve their goal of a finished product.

In the final Deliver phase of the Double Diamond the product undergoes final adjustments before manufacture and launch into the market. The farmer-inventors can find it difficult to fulfil all the roles required at this point of the commercialisation process: *“if you make the product, you’re a manufacturer, and then if you’re trying to sell the product, you’re a salesman, and then if you’ve to deliver the product, you’re a delivery guy... if you’ve to price a job it’s, you’re a quantity surveyor” (Mark).* For those who freely share their ideas, getting an invention into wider circulation can bring greater satisfaction than financial gain: *“I’d love [my idea] to be out there and I’d love it to be working” (Kevin).* This kind of peer-to-peer diffusion, a characteristic of user innovation, takes place through the farmer-inventors' networks which are also a source of user feedback.

The key informants stress the importance of user feedback on finished products, citing examples of agricultural machinery manufacturers: *“the bigger and the better ones are very, very good at that ... They have their user groups, their test groups, and ... they’ll take that and then put that into the R&D process” (K12).* One farmer-inventor is certain his invention meets customer needs:

“if I wanted to prove that I had invented one of the best inventions of all time for the Irish farm housewife, I would guarantee I could get women all the time. I could go back to them and say ‘What was the most important thing that made your life good?’ ‘The calf feeder’. I would win; on Irish farms, I would win that one, without a bother” (Declan).

Post-launch, the farmer-inventors continue to make changes and improve their products: *“I’m thinking about a new ... design because I know ... the weak point” (Alan)*, sometimes finding ideas in unexpected places:

“I finished up using the standard bain-marie that we have today ... I was working for years before I discovered ... it was in a chip shop one night ... up till I seen the bain-marie in the chip shop ... I was getting fellahs to weld up these little square yokes ... and there I sees the bain-marie and woo! You know, it’s kind of endless...” (Declan).

When talking about the evolution of their inventions the farmer-inventors consciously use the vocabulary of product development, one describes his progress with a new invention as: *“I’ve a lot of the R&Ds done now” (Declan)*. They employ terms such as: design, test, idea, invention, prototype, trial and error, innovation, market research, suggesting that they are familiar with the concept of and stages in new product development. They follow, informally and recognisably, the phases of knowledge divergence and convergence proposed in the Double Diamond model. However, unlike the process in firms, there is also evidence of learning from or collaboration with other farmers in their knowledge networks throughout the design of a new product, i.e. in practice-based problem identification, peer review of ideas, collaborative development and improvement, and peer-to-peer circulation of the finished idea – also features of user innovation.

6.5 Conclusions

In this chapter I have contributed to the research aim of this thesis by providing evidence to support the view that the farmer-inventors are involved in exchanges of knowledge and ideas with farmers and interested others with similar levels of embodied cultural capital in their

informal networks (RSQ5). With regard to the operation of their informal networks, I have provided evidence to support the view that farmers freely share knowledge and inventions in informal social learning networks and they connect in spaces such as agricultural shows or through the media, e.g. Practical Farm Ideas magazine (RSQ5). The free sharing of inventions occurs in some cases, more or less willingly, through public exhibition and networks at different levels (RSQ5).

The farmer-inventors receive advice on their day to day farming enterprises from formal AKIS actors (RSQ6). In connection with their inventing, the farmer-inventors have some interaction, individually and as a group, with the formal organisations in the AKIS, which they do not always rate highly (RSQ6). Some farmer-inventors seek validation, or institutionalised cultural capital, from AKIS actors by entering competitions or gaining a patent, while support to develop their inventions commercially is generally found to be absent or inadequate (RSQ6). In developing an invention from inspiration to production, the farmers follow a sequence of events that resembles the design process in firms, albeit more informally and very much a trial and error approach (RSQ2). Next, in Chapter 7, I discuss the findings from all the data, i.e. the content analysis and interviews, and identify the contributions to knowledge.

Chapter 7 – Discussion and Theoretical Implications

7.1 Introduction

In chapters 4, 5, and 6, I set out the findings from this research study arising from data collected in the magazine content analysis of 210 British inventions and, in the Irish context, semi-structured interviews with five key informants and in-depth narrative interviews with five farmer-inventors. In this chapter I present, first, the key findings summarised by research sub-questions 1-6. In this way I demonstrate that I have answered the research questions, set out in section 3.1 above, and achieved my research aim of investigating farmers' inventing activities, including their economic, social, and cultural motivators, the invention process and its outputs, and the networks of relationships involved. My contribution to knowledge, therefore, is to start to address the gap in the literature at the intersection of user innovation and sociological literature as it relates to agriculture.

In the second part of the chapter I discuss the findings I consider significant as they relate to my theoretical framework, that is, findings which I claim confirm or extend user innovation theory (von Hippel, 2005) and offer insights to Bourdieu's sociological theory of capitals (1986). As my focus is the subjectivities of farmers who invent artefacts, I present inferences and insights, rather than population level claims. I now present the findings under headings that pertain to the research sub-questions.

7.2 Findings Summarised By Research Sub-Questions

The overarching research question for this thesis is *'How do the motivators of Irish farmers influence their approach to the invention process and what are the outputs and the learning communities involved?'* I now summarise the findings from the data collection under the research sub-questions. At the end of this section I offer a perspective on inventions from British and Irish farmers relating to RSQ2.

7.2.1 Farmer-Inventors' Characteristics – Research Sub-Question 1

Research sub-question 1 looks at the type of farm enterprise, educational attainment and experience of the farmer-inventors, as well as the knowledge and skills involved in the invention process. As stated previously, a fundamental assumption here is that inventing and adapting machinery and other artefacts is very widespread in UK and Irish farming. The basis for this assumption is the evidence from the content analysis of the stories of British farmers' inventions and, in the Irish context, key informant and farmer-inventor interviews. These strongly indicate that farmers, both conventional and organic, invent across all types of farm enterprises, e.g. dairy, beef, and tillage.

In relation to farmers' education and experience, European data relating to the educational attainment of Irish farm managers shows that over two thirds do not continue beyond secondary school (Eurostat, 2014, p. 3; sub-section section 2.4.2 above). This was the case with the five farmer-inventor participants in this study, although all had undertaken some additional agricultural training. Their farming and inventing tacit knowledge and skills (e.g. welding/cutting, hydraulics) came from their experience as farm-born, lifelong farmers, gained primarily through social learning and their own trial and error. These knowledge-related findings link to sub-question-2 (the farmers' approaches to inventing), sub-question 4 (the functioning of farmer-inventors' informal networks) and sub-question 5 (knowledge hierarchies and the farmer-inventors' interactions with AKIS actors) below.

7.2.2 The Farmer's Approach to the Invention Process – Research Sub-Question 2

Research sub-question 2 relates to the process by which the farmers take their ideas to fruition, including the farming activity to which the invention relates, whether the farmer-inventor brings in outside help during the invention process, as well as characteristics of the inventions. The magazine analysis and the interviews suggest that farmers invent for a wide range of farming activities, from livestock handling to field machinery. They generally eschew outside help,

although they will get feedback on their ideas from trusted others; like farming, user innovation is a somewhat solitary pursuit.

The effect of the inventions, in terms of their creative development, was greater than expected, i.e. architectural inventions were more common than incremental adaptations, with no radical inventions in the sample. This links to the above findings on farmer-inventors' knowledge and skills in that formal education does not generally extend beyond secondary school yet, drawing primarily on their tacit knowledge, they create what can be complex and novel artefacts in a design process that is noticeably similar to that in firms. Viewed as a process of knowledge divergence and convergence the farmer-inventors' informal approach to product development involves, at all stages of the user innovation process, collaboration with and learning from trusted others with similar knowledge and skills.

7.2.3 Economic, Social, and Cultural Motivators – Research Sub-Question 3

Sub-question 3 relates to the farmers' economic, social, and cultural motivators for invention, in particular the influence of values and emotions, what other farmers think of the inventions, the social status of farmer-inventors, and how farmer-inventors compare themselves to other farmers.

According to Bourdieu (1990, p. 55), a person's habitus, i.e. their internal dispositions shaped by and reproduced in social interactions in cultural settings includes "*thoughts, perceptions, expressions, and actions*", which can be interpreted as enactments of values. The farmer-inventors interviewed for this thesis get great personal satisfaction from the technical challenge of inventing and are enthusiastic about problem solving. Their over-riding concern was the intergenerational duty, to both past and future generations, to preserve and improve the economic resilience of the family farm. This is acknowledged to be important in the Irish cultural context where family farming is dominant. The farmer-inventors interviewed are also active in their communities, often driven by values relating to transparency and fairness. All these values act as motivators to action through invention, spurred by emotions that can be regarded as a

form of embodied cultural capital (Katila, 2002, p. 191). Emotions that drive their inventing activities include love and commitment for the family and farm, optimism, passion, and perseverance. The farmer-inventors acknowledged the contribution of family support to their inventing. Mutual aid and reciprocal sharing of resources, often with those of similar levels of knowledge and skill, remain important to the social fabric of rural areas (see also RSQ5 below).

In giving priority to the financial stability of the farm business (McDonald et. al. 2014, p. 27), the farmer-inventors seek economic benefits in the use of their inventions and the anticipation of such benefits could be said to act as a motivator for invention. The benefits claimed for the use of the inventions were identified in the content analysis, and confirmed in the farmer-inventor and key informant interviews, with increasing efficiency, saving money, and reducing labour the most common. Despite the importance of economic efficiency and its usual role as a signifier of skilful farming, the farmer-inventors meet hostility and ridicule from other farmers when the inventions are brought into the public domain, to the extent that some are reluctant to exhibit their inventions. The inventions embody the farmer-inventors' knowledge and skills and it would seem that the application of such a resource to the invention process, as opposed to other types of farming activities, is not valued or seen as wasteful by their peers. In this way, the farmer-inventors breach cultural norms around what is an acceptable use of a farmers' time, knowledge, and skills.

All the farmer-inventors interviewed held different types of leadership roles in their community and were willing to challenge authority. Some are pioneering farmers, who try new farming methods and systems, even in the face of local scepticism. The ridiculing of a farmer's invention is viewed by some farmer-inventors as a sign of envy and highlights to them ways in which they are different to other farmers. Other ways in which they see themselves as different include being open minded, alert to opportunities, willing to take a risk, and having a high level of intellectual ability and technical skills. In addition, some farmer-inventors are strongly entrepreneurial and competitive which, in their view, further marks them out from other

farmers. I link these differences to the notion of a distinct farmer-inventor identity, which is discussed in relation to social learning networks in RSQ5 below.

7.2.4 Farmer-Inventors' Entrepreneurial Intentions – Research Sub-Question 4

The preceding section found that while farmers may look for economic benefits when using their inventions, their approach is also strongly influenced by social and cultural factors. Some farmer-inventors seek to exploit their inventions and RSQ4 relates to the entrepreneurial intentions of farmer-inventors and those farmer-inventors who have taken inventions to the market contemplated their experiences of commercialisation.

Not all the participants had attempted to commercialise their inventions, although all had thought about it. Some had tried to make a business of their ideas, with varying degrees of success, and two had patents. Their experiences of commercialisation suggest that farmers have an advantage relating to market knowledge and start-up costs, but these are often negated by constraints such as a lack of time and money, and not having the required knowledge and skills relating to, for example marketing and sales. The world of manufacturing and sales is too remote from farming for some, yet the support offered by formal AKIS organisations is found to be difficult to access and often not suited to their needs.

Those farmer-inventors who have won innovation competition prizes or achieved patents on their novel products (Francis, Declan, Mark) might be considered leading edge user-innovators, i.e. lead users. However, none have been approached by agricultural machinery manufacturers to take part in any lead user-type processes relating to new product development. This may be because such firms do not involve lead users or, indeed, any users in their R&D. They may also not rate farmers' inventions as being of sufficiently broad appeal in the market. This is a source of frustration for the farmer-inventors, some of whom, given the difficulties they face in commercialisation, would be willing to sell or licence their ideas to a manufacturer. Overall, the farmer-inventors feel that their inventions are not taken seriously by the AKIS organisations,

suggesting that the knowledge hierarchy, whereby scientific knowledge and formal qualifications are valued over tacit knowledge, may be at work.

7.2.5 Farmer-Inventors' Learning Communities – Research Sub-Question 5

Research sub-question 5 relates to the membership and functioning of farmer-inventors' informal networks, including free revealing of inventions in those networks and their resemblance to social learning communities. I find that farmer-inventors connect, both locally and more widely, informally and formally, with friends, neighbours, other farmer-inventors, and interested others to share resources, such as information, knowledge, skills, and encouragement. The strength of the ties within the informal networks depends, amongst other factors, on the proximity of the actors, as the distributed nature of farming means that making and maintaining connections can be difficult. That said, I find that the farmer-inventors' networks involve the three key elements of a community of practice:

- joint enterprise, i.e. shared goals in response to the farmer-inventors' context. All the participants invent to fulfil their personal and family objectives relating to job satisfaction and farm resilience;
- mutual engagement, similar to the reciprocity of social capital. It arises from the farmer-inventors' shared interest in new ideas and addressing knowledge and skills gaps;
- shared repertoire, i.e. communal resources such as stories and ways of doing things, which express membership of the community. The story of Harry Ferguson is mentioned by three of the participants and seems to be a cautionary tale in the lore of the farmer-inventors.

The sharing of tacit knowledge between members of the community of practice validates members' informal learning and group identity emerges from the ongoing negotiation of the meaning of practices, while shared values and norms contribute to trust and identification with other members. As discussed in relation to RSQ 3 above, the participants perceive themselves to be different to other farmers in some ways. I suggest that membership of a farmer-inventors'

community of practice supports an extended farmer identity that incorporates shared inventing practices and which cuts across the usual farming occupational identities (organic, dairy etc.). In response, other farmers try to impose a negative 'crazy' identity on the farmer-inventors, further entrenching the differences between them.

Another type of sharing in the farmer-inventors' communities of practice is the free sharing of inventions, an important feature of user innovation networks. I have shown that while some farmer-inventors seek to exploit their ideas commercially, almost all the inventions in the magazine analysis were offered freely to readers. All the farmer-inventor participants share their ideas at different times and for different reasons. One shares all his ideas in the hope of reciprocity, another is happy to share after getting the first use of his idea. One only shares ideas that have no market value, another shares reluctantly because commercialisation is too difficult. For the key informants, the practice of free sharing strongly challenged their rational economic perspective. I find that free sharing of farmers' inventions is more common than commercial exploitation, but I also recognise that the rate of commercialisation might increase if the obstacles faced by the entrepreneurial farmer-inventor were removed.

One inhibitor to the sharing of ideas is the risk of copying of marketable products. All the farmer-inventors, including the committed sharers, understand the process, advantages and disadvantages of Intellectual Property protection. Interestingly, the farmer-inventors will copy others' ideas, but blatant copying of market ready inventions by other farmers or firms is not generally acceptable.

7.2.6 Farmer-Inventors' Interactions with the Irish AKIS - Research Sub-Question 6

This sub-question considers the farmer-inventors' relationships with formal organisations in the Irish Agricultural Knowledge and Innovation System involved in arranging invention competitions, providing business support and farming advice, from the perspective of the farmer-inventors interviewed. It considers the nature of the interactions and how effective they consider the organisations to be in supporting their endeavours, as well as the participants'

opinion of the AKIS organisations. The farmer-inventors' experiences presented are not claimed to be representative of all Irish farmers' experiences or the result of a thorough evaluation of the AKIS organisations. I present the farmer-inventors' suggestions for how the AKIS support might be improved in Chapter 8.

The farmer-inventors interact with AKIS organisations in two ways: in connection with their everyday farming needs and as farmer-inventors seeking help to commercialise their inventions. The farmer-inventors have mixed views on the quality and relevance of the routine farming advice and support provided. However, they find the support offered to those wanting to take an idea to the market to be overwhelmingly inadequate. It is difficult to access, with the bar for entry being set too high, and not appropriate to their needs, in that the support is often pitched too low. The farmer-inventors are conscious of the knowledge hierarchy that deems tacit knowledge less valuable than formal education, while the culture of the AKIS organisations means they are not generally taken seriously.

The key informants confirmed this to a degree, in that they were aware of farmers' inventions that had been entered in competitions but not always the widespread nature of inventing and adapting. Being more focussed on inventions with commercial potential, some were sceptical about the farmers' invention process and their understandings of taking a product to market. None of the key informants mentioned agricultural machinery manufacturers that might be using lead user-type processes to involve lead user farmers in new product development. This indicates a lack of communication between what is happening at farm level and the AKIS actors. Being mainly interested in market-ready products, the organisations' criteria for help were often unsuitable for farmer-inventors. Notwithstanding this, some farmer-inventors seek validation from AKIS actors through patents and competition prizes. Overall, I find a disconnection in the relationship between the farmer-inventors and AKIS organisations. The AKIS organisations are largely unaware of the extent and nature of farmers' inventing and the support offered is often inappropriate. It may be that the organisation of the AKIS overall does not, in fact, facilitate

agricultural innovation, despite its purported aim. I now turn to the contribution of this thesis to the user innovation and sociological literatures.

7.2.7 A Multi-perspective View on Irish and British Farmers' Inventions (RSQ2)

In section 4.3 I set out examples of British farmers' inventions and whether they are mechanical or non-mechanical, and static or mobile and I close this section of findings by setting out similar information relating to the inventions of the Irish farmers interviewed (RSQ2). The stories of British farmers' inventions are derived from the content analysis, a quantitative method with 210 units of analysis, whereas Irish farmers' stories arise in the BNIM interviews, a qualitative method with five units of study describing 18 inventions. The aim is to contrast certain physical aspects of the inventions in order to highlight any similarities or differences that might contribute to the conclusions of this study. Notwithstanding the difference in methods and size of the datasets, I justify this exercise in two ways. First, the multi-perspective approach adopted here sees qualitative and quantitative data as complementary and, second, the manifest (i.e. not requiring subjective interpretation by the researcher) nature of the invention attributes to be described. This comparison is of interest because British farms are generally larger and more intensive than are found in Ireland (Eurostat, 2015, p. 40) with wider use of robotics and advanced technologies, which may not be compatible with Irish family farm structures or practices (Macken-Walsh, 2009, p. 20-21). However, it is also suggested that Irish farmers benefit from higher levels of training than their British counterparts (Eurostat, 2014, p. 3) and have been catching up with them in terms of productivity (HM Government, 2013, p. 15), so any differences may not be significant after all.

Over three quarters of farmers in the UK and Ireland have tractors (European Commission, 2016b, p. 7) and, similar to British farmers, the Irish inventions are often tractor-related. Powered mechanical inventions for use in the field include front loader extensions, post drivers, combined baler and wrapper, tilting land leveller, and a combined harrow and drill. Non-mechanical inventions related to the tractor are a working platform and gearbox bearing

remover. One Irish farmer also invented two self-powered mobile machines for turning turf and yard scraping.

Irish farmers' livestock related inventions are also mechanical and non-mechanical. Some are relocatable according to need, including a mechanical calf feeder, mechanical dosing system, and a non-mechanical poultry house. The farmer-inventors described their non-mechanical static livestock inventions as a clean water system, castration guard, crush retaining bar, and calving aid. One described a workshop invention for sorting different sizes of washers. No buildings, infrastructure, or process inventions or inventions involving ICT were mentioned. It is important to bear in mind that these inventions were described in stories told in a small number of interviews that covered many other topics and are likely not exhaustive.

From the 18 inventions described by the Irish farmers, we can see that, in terms of mechanisation and portability, the British and Irish tractor-related and livestock inventions are very similar. No difference in the farm activity to which the inventions relate was noted, except in the case of the Irish turf turner which be because turf harvesting is very limited in Britain. The data from the content analysis and farmer-inventor interviews provides evidence to support the notion that British and Irish farmers' inventions are similar in many ways.

7.3 Contributions to the Literature and Reflection on Theory

7.3.1 The Gaps in the Literature

Sub-section 3.2.2, above, sets out the justification for the focus of this study of user innovation in Irish agriculture by identifying two gaps in the literature, which are reprised briefly here. First, the user innovation literature (von Hippel, 2005, among others) is overwhelmingly approached from the economic and business disciplines, often based on survey methods, and there has been little exploration of social and cultural factors using qualitative methods. Second, user innovation research has paid little attention to agriculture, although the international development and farming systems literatures do consider farmers' inventions, but mainly in less developed countries. I present user innovation in agriculture by examining farmers' knowledge, motivators,

and inventions, in a more developed country from a sociological perspective for the first time. This represents a significant contribution to both the user innovation and sociological literatures by increasing our understanding of the social and cultural dynamics around farmers' inventing. In sub-section 3.2.5, I discussed how Bourdieu's theory of capitals (1986) might articulate with key elements of user innovation theory and in the following sub-section I build upon that articulation in order to set out the theoretical implications of the findings.

7.3.2 Farmers as User-innovators

This research adds to the extant user innovation literature by, firstly, confirming that user innovation in agriculture occurs as farmers invent useful products for themselves, without the involvement of firms. Many of the inventions are shared freely with other farmers, through their networks, whether face-to-face or through the media. This is in line with user innovation theory, which suggests that economic returns would be less important than social and cultural factors to many farmer-inventors. The user entrepreneurial process also differs from the traditional process by involving other users in the developmental stages of the invention before commercialisation is considered, and this was the case with the farmer-inventors. Nonetheless, I find that farmers differ from other user-innovators in four ways.

First, unlike most user-innovators studied to date (von Hippel et al., 2011, p. 28), who are graduates, the majority of farmers in Europe currently do not go beyond school education and rely on their own tacit knowledge and skills. Almost all the inventions identified in the content analysis were mechanical artefacts, but with a greater effect, in terms of the creative development of the artefact, than expected. The majority of inventions were categorised as architectural inventions, drawing on a range of knowledges and materials, rather than incremental improvements. The inventions of the Irish participants were mainly artefacts, mechanical and non-mechanical, and similar in many ways to the British farmers' inventions studied in the content analysis. The farmer-inventors' problem solving approach, which resembles the design process in firms, also suggests that their invention ideas mainly emerge

from their farming practice, i.e. they identify functional and tangible solutions to farming challenges, rather than abstract concepts. I find this extends user innovation theory in that tacit knowledge, as well as formal education, is a rich source of knowledge and skills for creative inventing.

Secondly, with regard to user-innovators, Hienerth et al. (2014, p. 850) suggest they can be well supported by their peers in the development of an idea, which was confirmed by the farmer-inventors with regard to those trusted others in their social capital networks. The evidence diverges from the literature with regard to public exhibition of the invention. Shah and Tripsas (2007, p. 131) describe how, for some user-innovators, the possibility of commercialisation occurs when *“public exposure creates interest in adoption, documenting demand, and sparking the idea of a commercial venture”*. However, the evidence presented here supports the notion that taking user innovation into the public domain is not always a trigger to entrepreneurship. In the agricultural setting, other users (farmers) may be a source of severe criticism and ridicule, often felt to be unwarranted, such that the user-innovator is reluctant to take the invention any further. Of course, not all ideas are good ideas, but the farmer-inventors describe a user community that, beyond their trusted advisers, is consistently hostile. I extend user innovation theory here in that exposure of an idea to peers does not always result in useful feedback that improves the idea or encourages its commercialisation, in fact, it can have the opposite effect. The social and cultural implications of this are discussed below at sub-section 7.3.3.

Thirdly, user innovation is generally seen as an outcome of hobby related activities, i.e. a pursuit associated with pleasure, not earning a living (Shah and Tripsas, 2007, p. 133). The theory allows that some user-innovators will develop, as a result of the positive feedback described above, entrepreneurial intentions for their inventions, called *“accidental entrepreneurs”* (p. 126), which, if successful, may extend the enjoyment associated with the hobby into their business life. The data suggests that most of the farmer participants identify as inventors, yet they do not fully subscribe to viewing their inventing as a hobby when it is so connected to their farming livelihood. By this I mean that while their inventing was aimed at increasing efficiency in their

farming business, which provides their main livelihood, they also get great pleasure from the inventing process. One key informant (KI 5) views the farmers' inventing as a pastime, which may explain why their inventions, and the tacit knowledge and skills they embody, are not taken seriously in the knowledge hierarchy operated by the AKIS actors.

The user innovation literature asserts the prevalence of the pleasure, rather than any economic benefit (Shah and Tripsas, 2007, p. 133), that hobbyist user-innovators derive from the use of their inventions. While farmers' motivators for invention are certainly social and cultural, I have shown that economic factors are very influential also. The evidence that all the farmer-inventors had thought about Intellectual Property protection for their inventions supports the notion that it is the farmer-inventors' willingness to consider taking their livelihood inventions to the market that marks them out from hobbyist user-innovators. It is not possible to say at what stage the entrepreneurial intentions arise, it may be the result of positive feedback, as suggested in the literature, or a driving force for their inventing, which is not discussed in the user innovation literature. I have shown that not all farmer-inventors act upon those intentions, some are committed sharers with alternative capital accumulation strategies. Most farmers' inventions were shared freely, as the user innovation literature suggests, yet the evidence supports the view that more farmer-inventors would seek commercialisation if the process was easier, as all the participants had considered it. I propose that user innovations arising from a farming business would not be shared as freely as those from hobbyist user-innovators if the commercial environment was receptive to entrepreneurial farmer-inventors.

Finally, turning to user innovation networks, I find that farmer-inventors' networks involve the free sharing or onward distribution of their ideas for reproduction and improvement. These can be face-to-face or virtual connections, with the farmer-inventor gaining network benefits, i.e. distribution of the invention, the stimulation of improvements, and increased reputation. This is consistent with user innovation studies to date. However, farmer-inventors also often enter a relationship of mutual exchange of resources with other users, similar to a community of practice. This results in the emergence of a group identity that, I argue, takes the form of an

extended farmer identity that incorporates inventing practices. Such practices might include the pleasure derived from the trial and error of problem solving, the public presentation of their inventions, and membership of knowledge networks. An individual may hold many identities and the performance of these inventing practices, e.g. at agricultural shows, reinforces those aspects of the inventor identity that go beyond their occupational farming identity.

Between the farmer-inventors interviewed there are also differences relating to their entrepreneurial intentions and the knowledge networks involved. This suggests that there may be another aspect of identity at work here, in addition to the practice based 'farming as an occupation' identity and its extension in the form of the farmer-inventor identity. I propose a 'diversifying farmer' identity which incorporates entrepreneurial practices beyond those involved in day to day running of the farm micro-enterprise (O'Gorman et al., 2012, p. 8). These may include actively pursuing ideas for new income streams outside the existing agricultural business, protection of Intellectual Property, and engaging with innovation support organisations. I propose that the emergence of the farmer-inventor and diversifying farmer identities extends our understanding of user innovation networks, beyond aspects of connectedness, so as to accommodate more fully aspects of community, i.e. group identities relating to inventing and entrepreneurship (Wenger, 2010, p. 9).

In this sub-section I have put forward the following extensions to user innovation theory that flow from the findings of this research project on farmers' inventions:

- tacit knowledge, not higher education alone, is a rich source of knowledge and skills for user innovation;
- exposure of an idea to peers does not always result in useful feedback that improves the idea or encourages its commercialisation, it can have the opposite effect;
- inventions from a farming business may not be shared as freely as those from hobbyist user-innovators;

- user innovation networks may also contain dimensions of community that lead to identification between members.

7.3.3 Farmer-Inventors' Economic, Social and Cultural Motivators

Bourdieu's theory of capitals (1986) provides a way to understand and describe farmers' economic, social, and cultural motivators for invention. In this section I present the insights arising from the data by building on the articulation between user innovation and capital conversion strategies described above. Using the different scenarios and experiences described by the participants I am able to set out here a detailed picture of these strategies, which may be unconscious. The aim of a capital conversion strategy is to improve a family's social status by converting economic capital to either cultural, social, or symbolic capitals.

In the following sub-sections I present, first, the strategy around the invention process and then describe three capital conversion strategies that might follow: the public exhibition, sharing, and commercialisation of the invention. I identify extensions and reinforcements to the sociological literature on farmer-inventors' economic, social, and cultural motivators. I now turn to the first scenario, the invention process.

7.3.3.1 The Invention Process

The invention requires an initial investment of economic capital, such as materials and time, as well as embodied cultural capital from the farmer. Access to formal education is often seen as a route to cultural capital, yet most farmers lack this opportunity. They compensate by gaining tacit knowledge and skills, which is perceived as having low status in the knowledge hierarchy, through social learning. At all stages of the design process, which resembles that in firms, additional embodied cultural capital is supplied by trusted peers, while family support is essential to the capital conversion strategy overall. I find that the invention artefact can be viewed as an instrument of capital accumulation that embodies the farmer's cultural capital. The inventions examined in the content analysis showed higher than expected novel effects, a form of objectified cultural capital, which can be converted to symbolic capital or economic capital.

Irish farmer-inventors' values arise in response to their habitus, particularly the relational setting (Scheer, 2012, p. 202), and they are motivated by their values of intergenerational family duty, farm resilience, personal satisfaction, and self-sufficiency. These values are underpinned by emotions, a form of embodied cultural capital, of their love and commitment for the family and farm, passion for inventing, and perseverance. I propose that the enactment of these values by the farmer-inventor points to an intergenerational capital conversion and transmission strategy.

In this sub-section I have provided evidence that supports and reinforces Bourdieu's (1986, p. 252) theoretical positions relating to the capital conversion strategies involved in the initial invention process in the following ways:

- the invention artefact can be viewed as an instrument of capital accumulation that embodies the farmer's cultural capital;
- enactment of family focused values by the farmer-inventor indicates an intergenerational capital conversion and transmission strategy.

The appropriateness of the values and emotions are influenced by the social structures within which an individual operates and I present the discussion relating to the public exhibition of farmers' inventions next.

7.3.3.2 Public Exhibition of the Invention

Farmer-inventors may lack the cultural capital associated with formal education and they seek alternative forms of capital through recognition from their peers as good farmers (symbolic capital) and by taking their inventions into the public domain at national agricultural shows and in the media (institutionalised cultural capital). As the research findings in Chapter 5 show, increasing efficiency and farm resilience may be good farming indicators but the farmer-inventors face severe criticism, which may be justified, from other farmers on the exhibition of their time and money saving inventions. Consistent with the interview data, I offer two possible explanations for this. First, most farmers invent useful things for themselves, perhaps to share with close friends and neighbours, so taking an invention into the public domain is seen as a form

of exhibitionism. In this case, inventing is commonplace and unexceptional, so public exhibition attracts ridicule.

Secondly, it is worth exploring the proposition, put forward by some of the participants, which is that the derision arises from other farmers' envy of their superior skills. The farmer-inventors' display of their knowledge and skills, as embodied in the invention artefact, visibly demonstrates their competence and, in the context of good farming criteria, esteem would usually be attributed to the skilful farmer. However, it may be that it is the investment of embodied cultural capital in the invention process that is not valued by the farmer-inventors' peers. In this way, the farmer-inventors breach cultural norms by an inappropriate or wasteful use of valued resources. It is not possible in this study to draw conclusions as to whether envy is an influence on the farmers' hostile responses to the inventions, but it is consistent with begrudging attitudes to entrepreneurs in Ireland. Taking the invention into the public domain often results in negative symbolic capital for the farmer-inventor, which can undermine their capital conversion strategy. I suggest that, in the Irish context, inventing by farmers is not considered culturally appropriate and may be linked to negative attitudes to entrepreneurs. For this reason, I also find public exhibition of the invention to be the key decision point in the farmer-inventors' process.

The decision to make public an invention involves a farmer's social status, which is bound up with the value attributed to their embodied cultural capital and that of wider family members. Pioneering farmers or those with community leadership roles will have additional symbolic capital, derived from peer recognition. Such farmers are better able to deal with negative responses to their inventions as their individual (and family) cultural and positive symbolic capitals balance out any negative symbolic capital, giving a 'mixed' social status. In this way, the ridicule acts as a counterpoint to the more prestigious social position of the community leader who is also a farmer-inventor. I find that farmers who are both pioneers and inventors are often willing and able to withstand critical feedback; some additionally have the entrepreneurial characteristics of risk taking and perseverance.

Further, the farmer-inventor's decision to persist, despite the ridicule of other farmers, signals an interplay between their social capital (their relationships with their peers) and their embodied cultural capital (the display of their inventions). In the public exhibition scenario the potential for the farmer-inventor to gain institutionalised cultural capital and symbolic capital is set against the risk of diminished social capital. Another element in this scenario is the performative aspect of the farmer-inventor identity, discussed in sub-section 5.5.1 above, which makes clear the distinction between them and other farmers. I propose this to be a means to increase and build social capital with those of similar social status and similar levels of embodied cultural capital, but it can also lead to negative symbolic capital from those farmers who take a different view.

At the same time, there are farmer-inventors who are short of social capital, for example part-time farmers, while those who are not community leaders or pioneer farmers lack the reserves of cultural and symbolic capital described above. I suggest that, in anticipation of, or as the result of, other farmers' criticism of their inventions, such farmers do not always pursue or repeat a public exhibition strategy. Some adopt a satisficing strategy, others a 'private' strategy. In behavioural economics, a satisficing strategy is *"to pursue not the best option, but a good enough option"* (Schwartz et al., 2002, p. 1178) and, in such cases, the farmer does not take their invention beyond the farm gate. This results in the potential loss of the economic and embodied cultural capital invested in the invention, which may only be recovered through economic efficiencies gained in its use. Being seen as an efficient farmer is a source of good farming cultural capital and the use of the invention may, in the longer term, improve the farmer's standing with their peers.

A private strategy involves the farmer-inventor sharing their ideas anonymously, as seen on occasion in Practical Farm Ideas magazine. Being deemed worthy of publication results in the farmer-inventor gaining institutionalised cultural capital in what I call a private form. Of less value than public recognition, it increases their status with their family and the trusted others with whom they share their ideas. Equally, appearing in the magazine involves a form of reciprocal sharing with other contributors and readers, albeit incognito, which is a source of social capital.

For the farmer-inventor who is motivated by job satisfaction and creative problem solving, pursuing a private strategy, along with the increased efficiency from use of the invention, may present a sufficient return on the economic and cultural capitals invested in the invention. It is, of course, possible that negative feedback on their inventions would lead them to pursue other capital conversion strategies, not mentioned by the participants, or even put them off inventing completely. Although I find that farmer-inventors generally persevere despite setbacks, I find that those who are reluctant to exhibit their inventions publicly adopt alternative strategies that may result in some improvement in their social status.

In this sub-section I have provided evidence that supports and reinforces Bourdieu's (1986, p. 252) theoretical positions relating to the capital conversion strategies involved in public exhibition of the invention in the following ways:

- public displays of the farmer-inventors' love for inventing, their technical skills, and entrepreneurial flair are often deemed culturally inappropriate in the Irish context;
- given the likelihood of social repercussions, public exhibition of the invention is the key decision point in the farmers' inventing process;
- farmers who are both pioneers and inventors are often willing and able to withstand critical feedback. This supports Shutes' (2003, p. 78) contention that pioneering farmers use their cultural capital to draw attention to or solve problems in their communities, thereby enhancing their social status;
- performance of the farmer-inventor identity establishes a distinction between farmer-inventors and other farmers, which can increase cultural capital and social status, but can also attract negative symbolic capital;
- those farmers reluctant to exhibit their inventions publicly may adopt alternative strategies that may well result in some improvement in their social status.

I find that the important decision to take an invention into the public domain, despite restrictive social and cultural norms, involves an element of risk-taking in a capital conversion strategy

which aims to preserve and increase the farmer-inventors' cultural and symbolic capitals, alongside the possible loss of social and symbolic capitals. For this reason I consider it the turning point in the farmer-inventors' invention process. For those whose capital conversion strategies go beyond public exhibition, two further options present themselves: free sharing or commercialisation of the invention. We turn now to the free sharing option.

7.3.3.3 Free Sharing of the Invention

Willingness to freely share an idea or invention is a central tenet of user innovation theory and a capital conversion strategy pursued by many farmers. The reciprocal sharing of resources in social capital relationships is a well-established cultural practice in rural areas, although agricultural restructuring means this may be in decline, as farmers increasingly share only with those with similar levels of cultural capital. In this way the free sharing of inventions can contribute to connectedness in the social capital network of like-minded people. As a capital conversion strategy, the building and maintaining of reciprocal relationships requires a donation of economic and cultural capitals, as embodied in the invention artefact, in the anticipation of access to another's resources.

The sharing of ideas and inventions can also bring symbolic capital in the form of trust, prestige and enhanced reputation to the farmer-inventor as their peers validate the embodied cultural capital invested in the invention. This, in turn, can be converted into economic capital, such as credit. Those farmer-inventors who have received criticism, or negative symbolic capital, for their inventions get pleasure from proving their detractors wrong, particularly if the critic then asks to borrow the invention. I suggest the sharing of a successful invention may, especially if assisted by the word-of-mouth culture of farmers' networks, result in the conversion of negative symbolic capital to positive symbolic capital.

The farmer-inventor's decision to freely share their invention suggests they favour a conversion strategy of social and cultural capitals relating to reputation, reciprocity, and social standing, over the economic capital that might be achieved through commercialisation. However, farmers

are micro-entrepreneurs and some only share their inventions because commercialisation is too difficult. In such cases, I find that the potential economic gains from commercialisation are preferred to the social and symbolic capitals and associated social status, gained through sharing.

In this sub-section I have provided evidence that supports and reinforces Bourdieu's (1986, p. 252) theoretical positions relating to the capital conversion strategies involved in the free sharing of inventions in the following ways:

- investing in social capital relationships is part of rural culture and is manifested through free sharing in the farmer-inventors' communities of practice;
- negative symbolic capital derived from criticism of an invention may be converted to positive symbolic capital through sharing of the invention;
- for entrepreneurial farmer-inventors the free sharing of inventions may be a capital conversion strategy of last resort.

The free sharing of inventions is part of a long term capital investment strategy which allows access to the resources of others, which I argue is suited to farmer-inventors who are situated in their locality, often over their lifetime. Next, I present the farmer-inventors' capital conversion strategies relating to commercialisation of the invention.

7.3.3.4 Commercialisation of the Invention

Commercialisation of an invention would seem to involve a straightforward conversion of embodied cultural capital to economic capital. However, I propose that, for the farmer-inventor, it is the riskiest strategy. The first step to commercialisation, and a form of market research, is often to enter an invention into a competition with the resulting potential for negative capital conversion as a social repercussion of public exhibition of the invention. Once the farmer-inventor has decided to exploit their invention then protection of Intellectual Property is considered. For the participants, a patent is a form of institutionalised cultural capital that may convert to economic capital in time. However, some farmer-inventors lack the economic capital (money, time) and embodied cultural capital (knowledge of and ease with bureaucratic

processes) required to get a patent, although some succeed. Farmers who invent novel products that win competitions prizes or achieve patents may be considered lead users, yet there is no indication that agricultural machinery firms in Ireland are using lead user processes.

Without Intellectual Property protection the farmer-inventor risks their idea being copied, a loss of economic capital, while those with experience of patents consider the cost of defending a patent often outweighs the benefits. Some farmer-inventors are over-confident in the marketability of their invention, further putting their capitals in jeopardy as they continue to invest in an invention that has little prospect of success. Those who decide to manufacture the invention themselves must invest further economic capital (in materials, equipment, premises, etc.) and embodied cultural capital (in marketing, sales, compliance with regulations etc.). I find that commercialisation of an invention requires significant additional investment of economic and embodied cultural capitals.

The sourcing of extra economic and embodied cultural capitals is an area of constraint for most farmer-inventors and they acknowledge that they need help from those with financial resources or relevant expertise. Some will call on resources from their social capital groups, while others seek help from formal organisations in the AKIS. The entrepreneurial farmer-inventors are generally dissatisfied with the support offered by the AKIS organisations as, when they qualify for it, it is often inappropriate. Further, the absence of lead user processes prevents the farmer-inventor from converting embodied cultural capital to either institutionalised cultural capital, through taking part in new product development, or economic capital, through licensing their inventions for production.

I find that farmer-inventors' tacit knowledge is not well understood or valued as the knowledge hierarchy that prizes scientific knowledge dominates the AKIS organisations and may well result in the negative attitudes to entrepreneurs often found in Ireland being applied to farmer-inventors by those organisations tasked with supporting innovation and entrepreneurship.

Another way in which the farmer-inventors are frustrated by their interactions with the AKIS organisations is that there seems to be no reciprocal obligation between the farmer-inventor and the AKIS actors, as might be found in the social capital relationship. This is despite long standing contact between them regarding routine farming matters, including the farmer-inventors providing resources to assist with agricultural extension activities. Some farmer-inventors find this difficult to negotiate and there is, currently, no incentive for the AKIS organisations to provide more suitable help. At the same time, the farmer-inventors, not being organised, have little leverage to compel a change of approach; this is discussed further in Chapter 8. I find that it is very difficult for the farmer-inventor to pursue a commercialisation strategy when their cultural, social, and symbolic capitals are not recognised by the innovation support organisations.

In this sub-section I have provided evidence that supports and reinforces Bourdieu's (1986, p. 252) theoretical positions relating to the capital conversion strategies involved in the commercialisation of inventions in the following ways:

- commercialisation takes the farmer-inventor into new and unfamiliar settings requiring additional investments of economic and cultural capitals, while putting at risk their existing resources of symbolic capital and social status;
- the knowledge hierarchy that prizes scientific knowledge dominates the AKIS organisations to the extent that the farmer-inventors' tacit knowledge is not well understood;
- it is very difficult for the farmer-inventor to pursue a commercialisation strategy when their cultural, social, and symbolic capitals are not recognised by key support organisations;
- the disconnection of the AKIS organisations from farmer-inventors means that opportunities to gain institutionalised cultural capital are restricted and negative symbolic capital may accrue following public contact with the AKIS organisations;

chances for leading edge users to work with manufacturers for mutual benefit are also missed.

Commercialisation is a long term, high risk, resource intensive capital conversion strategy which is made more difficult for the farmer-inventor by the detached approach of the AKIS organisations.

7.3.4 Reflections on Theory

The findings of this study also contribute to debates about aspects of the theories used in this thesis. Firstly, relating to user innovation, Bogers et al. (2010, p. 866) suggest that widening the theoretical basis of user innovation, albeit to include management perspectives, would provide greater coherence to explanations of why users innovate. However, the lack of in-depth consideration of social and cultural factors is considered here a lacuna in the theoretical framework of user innovation. This study has used sociological theory to explain economic, social, and cultural influences on farmers' inventing and I offer, as an example of a different theoretical lens opening up possible new understandings, a reflection on tacit knowledge and lead user processes.

It is posited in the literature that aspects of the tacit nature of user knowledge are an important influence on the user innovation process. Firstly, users become conscious of their needs only after repeated experience of a problem and, second, users are more likely to innovate because their sticky knowledge is difficult to transfer to firms to develop solutions for the market. Lead user processes have been developed as a way for firms to involve those whose awareness of user needs would provide useful inputs to new product development or whose own innovations would make commercially attractive products (Lüthje and Herstatt, 2004, p. 565). However, the findings of this study support the notion that in more developed country agriculture, which has not been studied to date, firms and agricultural researchers are not alert to or do not value farmers for either their knowledge of user needs or as innovators in their own right. This is suggested to arise from the knowledge hierarchy that prizes expert knowledge over tacit

knowledge. User innovation theory, therefore, perhaps due to its foundation on economic theories of innovation, does not anticipate the constraining effects of the social and cultural norms and values that may exist in firms and institutions on their ability to engage profitably and usefully with leading edge users.

Turning to Bourdieu's theory of capitals, I learned that while it allowed a strong analysis of the complexity and inter-relatedness of farmers' motivators for inventing, it was also limited in its analysis of aspects of social relations. In Chapter 2, I argued that social capital comprises two parts: the social relationship that allows an individual access to another's resources and the resources themselves (Portes, 1998, p. 3). It is also intangible, relying on reciprocity, trust and co-operation, yet the theory has been criticised for not adequately addressing issues of power and inequality associated with access to and exclusion from social resources (Adkins, 2005, p. 200). I found this to be the case when considering the findings relating to the social repercussions of farmers' inventing, i.e. the criticism and ridicule of their peers. Social capital networks, as evidenced by inter-farm cooperation, are well established in Ireland yet, despite the farmer-inventors seeming to hold abundant embodied cultural capital, the theory as applied does not explain the begrudgery of their peers which results in denial of or limited access to social capital groups and the resources, such as knowledge, support, and esteem, that may be available.

Another aspect of reciprocal exchange relates to farmer-inventors' knowledge communities. I used Wenger's social theory of learning to analyse the extent to which the farmers' networks operate as communities of practice (COPs) and found that the farmers' proximal networks contain the key elements of a community of practice. However, the theory's focus on the situated knowledge of an individual and its narrow view of learning as a means of improving practice does not address the collaborative co-creation of knowledge that occurs as farmer-inventors involve their trusted peers at different stages of the design process. Neither does it problematise the lack of effective brokering at the interface between the farmers' COPs (generally based on tacit knowledge) and those of AKIS organisations (generally based on codified knowledge).

While it might be possible to create the conditions whereby a COP might emerge (Ison et al., 2015, p. 108) that included farmer-inventors and agricultural researchers and innovation support staff, it is hard to imagine how that might work. The findings indicate a lack of trust in the AKIS on the part of the farmer-inventors and the AKIS organisations seem to hold farmers' individual and collaborative knowledge in low regard. Social learning theory offers an approach, developed over recent years in the field of natural resource management, which explores learning as an outcome of collaboration among multiple independent stakeholders in a social context (Ison et al., 2015, p. 112) and as a process of reflection and accommodations of multiple perspectives that can effect change in a situation resulting in concerted action (SLIM, 2004, p. 18). This involves the *"surfacing"* of framing epistemologies (Ison et al., 2015, p. 115) and requires a setting where *"proper facilitation, institutional support and a conducive policy environment"* (Ison et al., 2004, p. 39) are made available. This requires a commitment of resources by supporting institutions and participants, as well as facilitators appropriately skilled in systems thinking (Collins, 2014, p. 248). This is proposed as an area for future research below.

7.4 Conclusions

In this concluding section I draw together the findings relating to user innovation theory and the sociological insights into the social and cultural dynamics around farmers' inventing. My focus here is farmer-inventors who take their inventions into the public arena, although I acknowledge that most farmers adapt and invent items. As in the previous section I start with the invention process and then work through the three capital conversion strategies of public exhibition, free sharing, and commercialisation.

The initial invention process involves knowledge and skills and most user-innovators studied to date are graduates. In this study I have shown that farmer-inventors' tacit knowledge is also a rich source of knowledge and skills for user innovation and that they follow, albeit informally and collaboratively, a design approach that is similar to that in firms. The resulting invention artefact can be viewed as an instrument of capital accumulation that embodies the farmer's cultural

capital and the farmers' inventions showed greater than expected design effect. There are similarities between British and Irish farmers' inventions. The farmer-inventor is motivated to invent by personal satisfaction and passion, intergenerational values, and a duty to ensure the farm and family are financial resilient for the future. For this reason the main benefits claimed for the inventions are efficiency related.

User innovation involves other users to give feedback on the invention during the development stages and the farmer-inventors have a trusted circle of advisers. Taking the invention into the public domain is generally an opportunity for user-innovators to get feedback and encouragement. However, in the Irish agricultural setting, public displays of skills and entrepreneurial flair are generally deemed culturally inappropriate and attract strong criticism. The ridicule is a form of social repercussion as the farmer-inventors challenge the prevailing social and cultural norms relating to the use of valued farming resources, i.e. knowledge and skills. Interestingly, farmers who display their skills at heritage farming, music, sports, and local history do not face the same hostility.

Farmer-inventors with social status, for example pioneering farmers, are better able to withstand critical feedback as they have pre-existing social connections and peer recognition. Some farmer-inventors distinguish themselves from other farmers by the performance of a farmer-inventor identity that incorporates inventing practices and connects them with like-minded others in a community of practice. For reasons of context, I find that the decision to publicly exhibit the invention is the key decision point in the farmers' inventing process.

A central tenet of user innovation is the free sharing of inventions in user networks. In Ireland, reciprocal social capital relationships remain part of rural culture and most farmer-inventors will share some of their inventions, some of the time. User innovation networks may contain dimensions of community that lead to identification between members, while sharing of an invention that has previously attracted ridicule is a way to convert negative peer opinion to positive recognition through farming's word-of-mouth culture. Farms are micro-businesses and

some farmer-inventors have entrepreneurial intentions for their inventions and only share them freely because commercialisation is too big an undertaking. For this reason I find that user innovations arising in a business endeavour are less likely to be shared freely than those from hobbyist user-innovators.

Taking a product to the market takes the farmer-inventor into new and unfamiliar settings, requires additional investments of economic and cultural capitals, while putting at risk their existing resources of symbolic capital and social status. Many will seek help from formal innovation support organisations in the AKIS and most of them are disappointed at the help available. This seems to be because farmer-inventors' tacit knowledge is not well understood in these organisations and it is almost impossible, without some risk, for the farmer-inventor to pursue a commercialisation strategy when their cultural, social, and symbolic capitals are not recognised by key support organisations. The lack of awareness and understanding of farmers' inventing shows that the AKIS organisations are largely disconnected from the farm level and, particularly for manufacturers, important inventions may go unnoticed. In Chapter 8, following, I set out the farmer-inventors', and my own, suggestions for how things might be improved.

Chapter 8 – Conclusions

8.1 Introduction

Archaeologists studying 10,000 years of agricultural development find that innovations, small and large, have acted as “*catalysts for bigger changes*” ultimately leading to “*the rise of the state and our own modern world*” (van der Veen, 2010, p. 10). While it is hard to predict the future impact of the farmers’ inventions discussed in this thesis, it is acknowledged that the vast majority of contemporary farmers’ inventions go unrecorded (Bentley, 2006, p. 459).

In this study I have approached user innovation in agriculture, situated in the Irish context, through a sociological lens and from the perspective of the farmer-inventor. In this chapter I present, first, a summary of the thesis chapter by chapter, followed by the research questions and key findings. I then go on to discuss the implications of this research for European and national agricultural research and innovation policy and put forward the suggestions for operational changes for Irish innovation support organisations called for by the farmer-inventors. The chapter continues with my reflections on the research process as a whole, identifies some limitations of this study, and concludes with some suggestions for research that can build on and extend the work of this thesis.

8.2 Thesis Summary

The research aim for this thesis flowed from the review of the literature in Chapter 2 which identified a gap in the literature relating to user innovation in agriculture, which had not been studied in more developed countries, and the subjectivities of the farmer-inventor, which had not been considered in any depth by the user innovation literature. The literature review also discussed farmer-inventors’ relationships with the formal and informal organisations in the Agricultural Knowledge and Innovation System (AKIS). This provided the context in which user innovation and knowledge, as embodied in the invention artefact, and the influence of economic, social, and cultural factors on the farmers’ behaviour, were problematised.

My research aim, therefore, was to contribute to the literature by showing how economic, social, and cultural factors influence farmers' inventing behaviour, including the invention process and their learning communities. This research is important and timely because of the pressure on agriculture globally to meet the grand challenges of food security, climate change, and population growth, as well as the local imperative to improve small family farm viability. In Chapter 3 the research aim was crystallised in the research question and sub-questions and a multi-perspective methodology was developed to respond to the sub-questions, based on the ontological position that knowledge and innovations are socially constructed. The qualitatively-led approach involved quantitative (content analysis) and qualitative (semi-structured and narrative interview) methods, along with reflections on researcher positionality and ethics. Chapters 4, 5, and 6 presented the findings from the data collection, which were discussed in Chapter 7, and are synthesised next.

8.3 Key Findings

In the first part of Chapter 7 I addressed the over-arching research question: *How do the motivators of Irish farmers influence their approach to the invention process and what are the outputs and the learning communities involved?* by setting out the findings as they relate to the following six research sub-questions (RSQ):

- RSQ1 - What are the characteristics of farmer-inventors?
- RSQ2 - How do farmers approach the invention process?
- RSQ3 - To what extent are farmer-inventors motivated by economic, social, and cultural factors?
- RSQ4 - Do farmer-inventors have entrepreneurial intentions for their inventions?
- RSQ5 - To what extent do the ties between farmer-inventors and their informal networks represent a social learning community?
- RSQ6 - What is the state of the farmer-inventors' relationships with the formal organisations in the Irish Agricultural Knowledge and Innovation System?

In the second part of Chapter 7, I put forward contributions to the user innovation and sociological literatures in detail. In this section I synthesise the findings and present them as they relate to the farmer-inventors' approach to four key activities: the invention process and, relating to the invention artefact, its public exhibition, free sharing, and commercialisation. I then discuss the findings relating to the farmer-inventors' learning communities. In this way I demonstrate my contribution to knowledge by extending user innovation theory and by supporting and reinforcing Bourdieu's (1986, p. 243) theoretical positions on capital conversion strategies.

Firstly, regarding the invention process, in Chapter 4, I showed that the British inventions in the content analysis sample came from across different types of farm enterprises and related to a wide range of farming activities. Most of the inventions analysed improve efficiency in carrying out farming activities, suggesting an economic motivator for invention. In Chapter 5, which drew on interview data, I showed that Irish farmers' inventions similarly arise in a variety of farming enterprises and for use in a range of activities, yet their inventing behaviour is not only motivated by economic factors but also by their values and emotions, which respond to the social structures within which they operate. The responsibility to secure the farm for the next generation and honour the work of previous generations is a particularly powerful post-colonial cultural norm. In this way, the invention artefact works as an instrument of capital accumulation in an intergenerational capital transmission strategy. At the same time, farmer-inventors get great satisfaction from their creative problem-solving and, based on years of experience, farmers' tacit knowledge, and not formal education alone, provides a rich source of expertise for the trial and error of the invention process and the perseverance it requires. I showed, in Chapter 5, that the farmer-inventors' were also open to feedback and were willing to learn from others. This kind of knowledge exchange with their trusted farming peers at the developmental stage of an invention can result in constructive feedback that improves the invention, encourages a realistic approach to commercialisation, and can enhance the farmer-inventors' reputation. In Chapter 6 I contrasted the farmers' design process with that in firms and find they are similar, although the farmers' process is particularly reliant on input from trusted peers.

Once an invention has been developed, the farmer-inventor may put the invention on public display in an invention competition at an agricultural show or the media. This is the second of the key activities mentioned above and, in the Irish context, I have shown that taking an invention into the public domain can often expose the farmer-inventor to severe criticism or ridicule from their peers. The invention artefact embodies the farmer-inventors' knowledge and skills, as well as their love for inventing, and the hostility may arise from inventing being seen by other farmers as a waste of time and resources or its public exhibition as a form of bragging. In the Irish context, where entrepreneurs are not always held in high regard, begrudgery (the denial of another's success) may also be at work. The lack of regard for both the knowledge and skills involved in inventing and the public performance of the inventor identity serves to underscore differences between the farmer-inventors and their farming peers.

Those farmers who are willing to risk such hostility often have social status associated with the pioneering of new farming methods or the undertaking of wider community roles, e.g. involvement in farming organisations. They may also seek alternative forms of validation by entering competitions, appearing in the media, or through recognition by other farmer-inventors and respected others. Those farmers who are reluctant, due to the ridicule, to exhibit their inventions publicly may adopt private or satisficing strategies to enhance their capital status in a limited way. For these reasons, I consider the decision to take an invention into the public domain to be the key decision point in the Irish farmer-inventor's capital accumulation strategy.

Turning to the third key activity, the free sharing of the invention, the exchange of resources is part of rural culture and I have shown, in Chapter 6, that building reciprocal relationships with trusted peers is important for farmers' inventing. It gives them access to, for example, the knowledge and skills of other farmers during the development of the invention, with the idea or artefact shared freely in return. Free sharing of the invention means that the farmer-inventor cannot protect their Intellectual Property and therefore gives up the prospect of commercialising the invention. Although some farmers, as micro-entrepreneurs, only share their inventions because commercialisation is too difficult, for others sharing is a matter of principle and tradition

which can enhance their social status locally. I find that inventions from a business endeavour may not be shared as freely as those from hobbyist user-innovators.

When it comes to the fourth key activity, commercialisation of the invention artefact, farmer-inventors recognise that it requires significant investments of money, time and skills, which they may not have. As micro-entrepreneurs, they already have experience of the market for their farming production, yet the milieu for their invention may be very different, requiring new skills and no little confidence. Running a farming business also means that the farmer-inventors are familiar with the risks associated with starting a new enterprise and, given their constraints, many farmer-inventors would prefer to sell or licence their ideas to someone else who can take it further, thereby reducing their financial risk. However, agricultural manufacturers do not seem to engage with farming lead users who might have knowledge or inventions to exploit. For those farmer-inventors who decide to proceed with commercialisation I have, in Chapter 6, shown that taking a product to the market is made even more difficult by the lack of recognition and appropriate help from innovation support organisations in the Irish AKIS. Farmer-inventors' tacit knowledge and invention processes are not well understood in these organisations and their social status, achieved through performance of the inventing identity or their wider community roles, is not recognised in any significant way. I link this disconnection to the domination of scientific knowledge in agricultural research and innovation policy, which is discussed further below.

All the farmer-inventors talked of the ties that facilitate their social learning, i.e. the sharing of knowledge, skills, and information in their networks of relationships, which resemble a community of practice. I have shown, in Chapter 6, that social learning arises from the farmer-inventors' shared interest in new ideas as they strive to fulfil their objectives relating to job satisfaction and family farm resilience. This includes seeking input from trusted peers to their design process and they do this through a shared repertoire of practices and lore, such as the story of Harry Ferguson. I also propose, in Chapter 5, that these shared approaches have led some of the farmer-inventors to adopt a distinct farmer-inventor identity. They describe ways in

which they are different to other farmers: being more systematic in their work, open minded, and with a higher level of intellectual and technical skills. There is also a performative element to the farmer-inventor identity as they publicly distinguish themselves from other farmers by, for example, displaying their inventions, itself a performance of technical expertise, or performing a sales role. This can elicit a negative reaction from other farmers, but it also builds recognition and esteem with those of similar levels of knowledge and skills. Next, I set out the implications of the findings set out in this section for policy and practice.

8.4 Implications for Policy and Practice

I set out, in chapters 1 and 2, the policy relating to agriculture and innovation in Ireland, as a member of the European Union, and the organisational context, conceptualised as the AKIS. Here, I set out some implications for policy of this research and then make suggestions for changes to operational practice in the AKIS organisations, based on suggestions from the farmer-inventors who participated in this project.

8.4.1 Implications for Agricultural Research and Innovation Policy

The European Union's strategy for agricultural research and innovation (European Commission, 2016c, p. 35) requires the AKIS to move towards a more networked approach for mutual learning between farmers and other actors. The European Innovation Partnership (EIP) is the vehicle proposed to bring about this change and, although the EIP approach is relatively recent, its early projects have involved farmers as partners in research projects, as co-creators of knowledge. While this open innovation model represents a shift away from earlier top down, linear approaches, it does not seem to fully recognise farmers' own creation of knowledge and inventions, i.e. user innovation. That said, there are countries that have shifted towards a more user-led innovation policy, as seen in Finland (Ministry of Employment and the Economy, 2015, p. 28), and those where farmers' organisations have a leading role in the development of innovations, as seen in Denmark (Madsen-Østerbye, 2014, p. 27). As the range of projects under the EIP grows, I propose that an EU-wide best practice forum be set up for the EIP-AGRI so that

novel or impactful approaches to encourage and support user involvement are shared and evaluated. Such a forum would facilitate closer co-operation between farmer-inventors and agricultural researchers in knowledge exchanges where tacit and formal knowledges are more equally valued, as well as encouraging and supporting farmers to bring forward their inventions for further development and wider distribution. Greater recognition for farmers' tacit knowledge and inventions might be challenging for some agricultural researchers and advisers who are embedded in and have achieved status through the knowledge hierarchy. I propose that a programme of cultural change is required to shift the attitudes in institutions concerned with agricultural research, education, and advice across the EU, including Ireland. As we have seen in chapters 1 and 2, the encouragement of farmer-inventors is not currently the approach taken in Irish agricultural and innovation policy.

In Ireland, there are two government departments involved in agricultural innovation with slightly different approaches to user innovation. The Department of Agriculture, Food and the Marine (2015, p. 48) views the EIP as a way to “strengthen linkages between the results of research and innovation and their implementation at farm level” suggesting that the top down knowledge transfer approach persists. The Department of the Environment, Community, and Local Government (2015, p. 31) on the other hand, which funds the Operational Groups under the EIP, sees them as a means to “foster the submission of innovative concepts and ideas from farmers”, suggesting that farmer-inventors would be encouraged to bring forward their ideas. This may seem like an insignificant difference of emphasis yet, I argue, the approaches and practices of organisations involved in achieving the policy ambitions are influenced by the wording of policy documents. My observations from my own career in designing and implementing policy interventions in the UK is that such wording is often pored over as implementation organisations develop their priorities and is relied upon to justify their policies and procedures.

Given the ongoing setting up of Operational Groups in Ireland, and in light of the timely evidence provided by this research on the extent of farmers' inventing, it is suggested that the relevant

departmental policies should be reviewed and better aligned to prevent participants falling between programmes, as described by the farmer-inventors. The review should ensure that the role of farmers as proactive problem solvers and inventors, and the social and cultural influences on inventing, be given greater prominence in the policy documents. The monitoring and evaluation criteria for the implementation of these policies should be adjusted so that farmer-inventors' access to the programmes is targeted, qualitative social and cultural dimensions incorporated in the evaluation measures, and the outcomes made transparent. This is especially important for those low cost inventions aimed at improving small family farm efficiency, two thirds of which in Ireland make no profit from their farming businesses. Such farmers are often determined to maintain the farm for future generations and government policies that incentivises more intensive farmers, by supporting investment in new technologies to meet production targets over support for struggling small farmers, would seem to be at odds with the social and cultural values of two thirds of Irish farmers. This research shows that the lack of a specific policy and programmes to support small family farms in Ireland is holding back those farmers who, like the farmer-inventors, may have innovative ideas of their own to improve farm resilience.

8.4.2 Suggestions for Innovation Support Organisations

I now turn to the policy and operational suggestions of the farmer-inventors interviewed, based on their experience of dealing with Irish AKIS organisations relating to their inventing activities. While they acknowledged the expertise of the staff in the AKIS organisations, they felt overall that they and their inventions are not taken seriously.

Farmer-inventors looking to explore the commercialisation potential of their inventions find support (advice, training, skills, and funding) difficult to access and propose that the signposting between different organisations and programmes should be improved or the programmes reconfigured to streamline application processes: a one stop innovation hub was suggested. To ensure the widest participation, access criteria should be redefined to ensure that all farmer-

inventors can avail of support. Once accepted into a programme, support should be suitable for farmers, who as micro-entrepreneurs already have some experience of the business environment, and also suitable for farm-based manufacturing enterprises, which have different needs to other types of businesses, such as help with Intellectual Property protection.

The support should also be appropriate to the farmer-inventors' circumstances. At one end of the current support spectrum are full-time training programmes that take the farmer away from their farming business and, at the other end, the distribution of information leaflets alone, neither of which are considered adequate or appropriate: on-farm tailored advice or training was suggested. Where programmes are operated by different organisations or from different funding streams, communication between AKIS organisations should be improved so that farmer-inventors can move seamlessly from one support programme to another, as necessary. The failure of the AKIS organisations to offer support that is appropriate to farmer-inventors suggests that they do not fully understand their needs and it is suggested that regular assessments of their requirements be carried out, as well as training for staff to improve understandings of farmers' knowledge and inventing.

Those farmer-inventors who decide to make a business of their invention find access to the right type of finance, according to their stage of business development, to be difficult and bureaucratic. If they succeed in getting funding, they find the conditions attached to grants, loans, credit, and other investment vehicles, such as requirements about professional qualifications, financial records, and standards, to be burdensome, costly and, sometimes, counter-productive. A co-ordinated approach to providing information on the range of support available and, given that the farmers are likely facing farm viability pressures, advice on general financial matters and managing risk would be welcomed. Schemes aimed at supporting farm diversification would benefit from input from farming organisations to ensure that they meet the needs of farmers while protecting the interests of financial investors.

The farmer-inventors recognise that not all their ideas are going to succeed as businesses and consider feedback on the likelihood of commercial viability and advice on market strategy to be a very important element of the support they seek. At the moment, the only opportunity for feedback on product feasibility is through entering an invention competition. This presents the farmer-inventor with a dilemma: in order to have access to some expert advice, although not all the farmer-inventors consider the judges to have relevant expertise, they expose themselves to the risk of ridicule. It is not surprising therefore that some farmer-inventors would like the opportunity to demonstrate their inventions in the farm setting, away from the public gaze. This would also enable them to get feedback on ideas earlier in the invention process, building on the input from their social learning group. As discussed above, taking an invention to the market requires an investment of money, time, and skills that the farmer-inventor may not have. Where they lack specialist skills, such as market research and sales, signposting to competent practitioners with relevant experience is essential to taking the business forward. Some would be interested in selling or licensing their ideas to manufacturers and want the AKIS organisations to be proactive in facilitating negotiations with agricultural engineering and other companies looking for ideas. These kinds of collaborative partnerships could well be eligible for Operational Groups status under the EIP and the farmer-inventors would value this sort of ongoing support beyond the initial advice stage. It remains to be seen if any of the AKIS organisations use the Operational Groups model in this way.

Some of the farmer-inventors talked about forming an Inventors' Association, a form of social innovation, which might help them to build networks and give them greater influence with AKIS organisations. A self-organised farmer-inventors' group would have the freedom to challenge the prevailing authorities, which they are very willing to do and also to claim space and recognition for their inventing activities in the overall AKIS. However, engagement with the organisations in the AKIS will depend in part on the extent to which the farmer-inventors wish to become institutionalised in the AKIS, which may reduce their freedom to critique the system. For the AKIS organisations, the greater involvement of farmer-inventors in AKIS processes may

not be seen as beneficial, particularly given the challenges to status and power that the farmers' knowledge and inventions present. Should involvement be encouraged, as the result of successful lobbying by the farmer-inventors, then it may be treated as symbolic by the dominant group, particularly given their focus on intensification through digital technologies rather than mechanical inventions suited to the small farm.

It may be that the farmers who took part in this study, as inventors of mainly efficiency focused mechanical artefacts, would have more in common with alternative networks that seek to promote low cost farm-level innovation, such as the Maker and open source movements. However, I do not underestimate the dominance of the knowledge hierarchy that gives formal knowledge greater status than tacit knowledge in the Irish AKIS. The European agricultural research strategy (European Commission, 2016c, p. 29) recognises that the implementation of participatory approaches in multi-actor research Operational Groups depends upon a "facilitating environment". One of the farmer-inventor participants hoped that "the one thing that could come out of this ... is that if I could change the attitude of Teagasc towards inventors" (Declan). Creating an enabling research environment like this will, as I argue above, require a culture change in many Irish AKIS organisations to ensure that farmers' knowledge is better recognised and celebrated.

Only one third of Irish family farms make a profit from their farming business and in this section I have set out some policy and practice suggestions that, given the unique nature of the farming occupation, would go some way to providing appropriate support for farmer-inventors to develop their inventions, some of which may be brought to the market. These are not the digital technologies promoted by government agencies but low cost efficiency inventions that might be attractive to the struggling small farmer.

8.5 Personal Reflections and Study Limitations

8.5.1 Personal Reflections

I started this PhD project straight from a Master's degree where I had problematised farmers' knowledge and practices in the context of rural protests relating to environmental governance regimes. Here, I looked at inventing as another facet of farmers' tacit knowledge, which I suspected suffered from the same lack of understanding and status with the Irish government and its agencies. The farmer-inventors' experiences confirmed this is the case, as the organisational contextual, i.e. the culture, policies, and practices of the organisations of the AKIS, contributes to a situation whereby those who pursue commercialisation for their inventions, whether incidentally or intentionally, are sometimes thwarted by the lack of appropriate support on offer.

I did not, however, expect to find that farmers' creative knowledge and inventions lacked status and were deemed culturally inappropriate by their farming peers and, further, that some farmer-inventors would not take their inventions into the public domain because of the ridicule they might face. Similarly, the free sharing of knowledge and inventions in the farmer-inventors' learning communities, a dimension of user innovation which involves the forgoing of Intellectual Property rights, confirmed that social and cultural factors, such as the desire to safeguard intergenerational legacies and build reciprocal relationships, were as influential on farmer-inventors' behaviour, if not more so, than economic factors. These contextual and dynamic influences are often neglected by agricultural innovation research in more developed countries, particularly in research on technology adoption.

Having witnessed the solidarity between farmers involved in the turfcutting protest I was not surprised to find that some of the farmer-inventors were thinking about organising themselves into an association in order to build a wider network of likeminded people and increase their negotiating power with the AKIS organisations. I also reflected on the social capital I had built with the farmer-inventors. By this I mean that I was often asked to share my knowledge and

experience relating to, for example, other inventions I had seen, information or contacts that might be useful to them, and agricultural issues more generally. While I felt that this was a fair exchange for the time and hospitality they had given to me, it also signified my growing knowledge and confidence in agricultural matters and my credibility as a researcher.

Before starting fieldwork I had reflected on the insider-outsider dynamic and thought my outsider status and lack of farming background might inhibit the participants' sharing of their experiences. Following the interviews with the farmer-inventors, I now consider that being an outsider was an advantage in that context as they did not associate me with the prevailing negative cultural responses to their inventions. The interview method I used with them, the Biographic-Narrative Interpretive Method, also provided an open space for them to share their subjective experiences, which resulted in much rich data. A learning point is that I might usefully have followed up the interviews with further discussions with the participants on their experiences of being interviewed by an older English-accented woman.

Finally, I have found the PhD process to be both testing and exhilarating. Working productively for four years between two institutions in two countries, with three core and two shorter term supervisors, demonstrated my self-management skills. I have shown that I can work independently and flexibly, for example when, due to organisational and management issues, my research design had to change once I was in Ireland. Overall, the PhD has been a great opportunity to develop my intellectual capabilities and research skills, with the support of my supervisors and other colleagues, and I remain curious and inspired to pursue whatever research challenge comes next as much as I was when I returned to study in 2011. Now, I outline some limitations of this thesis.

8.5.2 Study Limitations

Here I identify three limitations of this study relating to the methodology. Firstly, I used a small sample of interview participants in order to gather rich in-depth data on the life experiences of the farmer-inventors and key informants. This has allowed me to make inferences relating to the

theoretical framework, rather than population level claims. I do not consider this to be a significant limitation, as it is the expected outcome of qualitative methods, and my research design allowed for multiple perspectives of user innovation to emerge. Second, the farmer-inventors' sample consisted entirely of men and I acknowledge that a gender balance was not achieved and farm women's inventions are considered to be a relevant topic for future research. Thirdly, I set out the limitations of the data source for the content analysis in detail in Chapter 3 and, while I do not claim that the inventions are representative of all British farmers' inventions, the findings were influential on the development of the remaining stages of the research in the Irish context.

8.6 Suggestions for Further Research

User innovation in agriculture in more developed countries has not been studied before and, as a result, I make a number of suggestions for further research:

- Bourdieu's theory of capitals (1986) is a fundamental sociological theory yet it is rarely operationalised in policy discourses. This compares to Putnam's (1995) social capital theory, which makes societal claims and has had an impact on policy. However, as we have seen, agricultural discourses are mainly economic and increasingly environmental, with little emphasis on social and cultural influences, which are regionally and locally specific. Further research could usefully focus on how the policy-practice dynamic (at all levels) could be enriched by broadening the discourses in agriculture to include social and cultural factors;
- The user innovation literature acknowledges that the free sharing of inventions is contrary to the mainstream economic literature that views the farmer-inventor as a rational economic agent. Further research using the lens of behavioural economics would provide a psychological foundation for user-innovators' sharing activities and, perhaps, a recognition that decision-making is contextually rational and often value-led;

- This thesis uses the AKIS model as a framing device to study the interactions between farmer-inventors and innovation support organisations. However, a number of further research questions arise that could be usefully studied using systems theory as a fully integrated part of the theoretical framework: how might the innovation platform model be used to explore issues of institutional capacity to provide support for farmer-inventors in the system; how might Bourdieusian capital conversion strategies be incorporated into a systems diagram or model; do the farmer-inventors' networks represent a shadow AKIS or are they social innovations that bring forth a type of bricolage AKIS, which is spontaneous and provisional;
- The lack of appropriate support offered to farmer-inventors by the AKIS organisations indicates a poor understanding of farmers' inventing processes and there seem to be few opportunities for meaningful engagement outside the agricultural shows or expert - client relationship. If farmer-inventors are to be *"recognised for what they do and not just for what they are"* (Ison et al., 2004, p. 7) then social learning approaches could offer a way forward. Claiming to have achieved *"the transformation of individual and institutional behaviour, at large social scale ... through deliberate investment in multi-stakeholder learning processes"* (Ison et al., 2004, p. 6) in natural resource management settings, further research could investigate how a social learning system might be designed in the context of user innovation in agriculture;
- This research has focused on artefactual inventions as an observable means to investigate user innovation in agriculture. I have also presented evidence that farmers' inventions include process and social innovations, demonstrating farmers' interests in broader opportunities for innovation, and I suggest further research into institutional and practice-based user innovation in agriculture;
- The predominance of artefactual inventions in the data raises questions about the extent of agricultural machinery manufacturers' awareness of and response to farmers' needs. A study of the prevalence of the lead user approach in agricultural machinery

manufacturing might lead to greater understandings of the role of user innovation in the machinery market;

- Farmers are different in many ways to other occupations studied relating to user innovation. They are usually sole traders or micro-enterprises, subject to distinct and prescriptive policies, whose practices are visible to the public, as seen in roadside farming and in their effect on landscapes. Farmers' situatedness and attachment to the land also means they are socially, culturally, and geographically different to other occupations. Further research could usefully explore how user innovation in agriculture manifests in other more developed countries, particularly those in a non-European policy context. Equally, a comparison of user innovation in agriculture with user innovation in other occupations or micro-enterprises in the Irish context might be revealing about institutional and organisational influences and support;
- Women farmer-inventors, like their male counterparts, have not been studied in more developed countries before, and the extent to which farmers' inventions are a co-production with their families are two topics that are worthy of further research;
- This study has considered farmer-inventors' values and emotions from a sociological perspective but their psychological personality traits, such as creativity, tenacity, and daring, which may mark them out from other farmers and other entrepreneurs could be a fruitful area for future research.

8.7 Concluding Remarks

There have been 10,000 years of agricultural progress yet the majority of contemporary farmers' innovations, and the attendant knowledge, are largely neglected by scholars and policy-makers, circulating only within user communities, often at no charge, while the market only becomes interested when demand reaches commercial levels (von Hippel et al., 2011, p. 29).

The central finding of this research is that Irish farmer-inventors create useful artefacts that can improve efficiency but, due to cultural norms and the status of farmers' knowledge, they are

often derided by other farmers and under-appreciated by the organisations tasked with supporting agricultural research and innovation. This research is timely as Operational Groups under the European Innovation Partnership, aimed at co-production of knowledge and innovation between farmers and researchers, start to be implemented in Ireland.

My hope is that this research will encourage greater understandings of how farmers use their tacit knowledge to invent useful farming artefacts, as well as the challenges and constraints that they face in bringing their inventions to the wider community. The potential of these inventions, undoubtedly including some of significant promise, should not be dismissed, as we saw with Declan's calf feeder in Chapter 1, particularly at a time of grand challenges facing agriculture globally and the precarious financial state of small family farms in Ireland.

Appendices

Appendix 1 – Project Update for Interview Participants, July 2016

Appendix 2 – Content Analysis Coding Manual

Appendix 3 – Key Informant Interview Guide

Appendix 4 – Information Leaflet for Interview Participants

Appendix 5 – Consent Form for Interview Participants

Appendix 1 - Project Update for Participants, July 2016

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Project Update July 2016 – Irish Farmers and Their Inventions

Why am I receiving this update?

In 2015 you took part in a research study looking at farmers who invent useful products for themselves. Farmer-inventors and representatives from organisations, such as Teagasc and Enterprise Ireland, were interviewed by Trish O’Flynn, PhD student with Teagasc and the Open University. You were sent a copy of your interview transcript. Since you were interviewed Trish has analysed what you told her and has identified some common themes. This update sets out those themes and invites your comments **by 31 August 2016**.

What you told us - why do farmers invent?

Most farmers will look for solutions to practical problems they face in their day-to-day farming. Farmers invent for mainly economic reasons, across all farm activities and farm sectors. Inventions increase efficiency, by saving time, labour, or money, and improve productivity; some farmers turn their inventions into a business. Farmers also invent for family and personal reasons. Improving the financial position of the farm is a way to secure their children’s future and to honour the work of previous generations. Farmer-inventors get great satisfaction and enjoyment from solving problems. They are willing to fail and persevere to overcome technical challenges. Some are competitive with their inventions and want to be the first in their field.

What you told us – how do farmers go about inventing?

Turning an idea into an invention requires knowledge and skills, creative use of tools and materials, trial and error, and a willingness to try new things. Most farmers are self-taught, gaining knowledge through experience, talking with other farmers and advisers, and watching others perform a task. This is called social learning and the farmer-inventors believe this type of knowledge is not well understood by those in government agencies and other organisations. Formal education and agricultural training also play a part, although many farmers do not go beyond school education; this was a regret for some. Family support is important to the farmer-inventor at all stages of the process.

What you told us – what do others think of the inventions?

Most farmer-inventors have a trusted group of family, farming friends, and advisers who give them feedback on their ideas. Taking an invention into the public arena, such as an agricultural show, can be risky as other farmers can be very critical and not always in a helpful way. For some, this criticism puts them off taking their invention beyond the farm gate. On the other hand, winning a prize in a competition encourages the farmer-inventor, but the judges are not always thought to be up to the task. Government agencies and other organisations do not always see the potential in an invention and are mostly interested in market-ready products.

What you told us – how easy is it to commercialise an invention?

Many farmer-inventors would like to make a business from their invention yet face many obstacles in setting up a new enterprise. They must invest time and money, which is often in short supply, in getting the invention market-ready. Legal requirements, such as patents and safety certification, are complicated and costly. If the farmer-inventor were to manufacture the product, then further investment in materials, equipment, and labour is necessary. Taking a product to the market also involves extra skills, such as research, marketing, or sales, which the farmer-inventor often does not have.

What you told us – why do some farmers share their ideas for free?

Not all farmer-inventors want to be entrepreneurs. Some believe that sharing their ideas with other farmers is in keeping with tradition and a good thing to do, as it encourages others to share with them, and they get pleasure from seeing their inventions being used by others. Sharing happens between neighbours or through wider networks of like-minded farmers. Some share their ideas via magazines, such as Practical Farm Ideas, or the Internet. All recognise that sharing an idea means that the farmer-inventor cannot claim the Intellectual Property for their idea. Copying of ideas is expected and, in some cases, seen as inevitable. However, some farmer-inventors would not share as much if commercialisation was easier.

What you told us – where do farmer-inventors get help?

The farmer-inventors who took part in this study were aware of the financial risks involved in setting up a new enterprise and the challenges facing small businesses in a global market. They need help with resources and skills and most have approached the organisations involved in supporting agricultural innovation. They find that while individual staff members are helpful and knowledgeable, support is hard to find and they do not always meet the criteria. The support that is on offer does not meet their needs, has little or no follow-up, and is subject to such restrictive rules that the support is often not worth taking up. The organisations seem to overlap

and there is not much signposting to alternative places to find help. Overall, the farmer-inventors are frustrated by the help on offer and feel they are not always taken seriously by the support organisations.

What you told us – how might help for farmer-inventors be improved?

The support organisations have suffered cuts to funding and staff that have reduced their capacity to offer support and the farmer-inventors had some suggestions for improvements. First, farmer-inventors' contributions should be recognised and respected. Resources should be reorganised within and between organisations to provide support suitable for farmers and with less bureaucracy. Support packages should be drawn from more sources to reduce risk and offer realistic feedback about the likelihood of success of the invention. One practical suggestion is for the organisations to research manufacturers' needs and match them with the relevant farmer-inventor. Some farmer-inventors recognise that they do not have much negotiating power at the moment and that organising themselves into an Association or similar might be of benefit.

What happens now?

These findings as well as comments received from yourself and the other participants will feed into the final report of the project. If you would like to comment on this update then either get in touch with Trish (her UK contact details are below) **by 31 August 2016** or she will call you at the end of August on the contact number or email she has for you.

Is my response confidential?

Yes. Your participation will be treated in *strict confidence* in accordance with the UK Data Protection Act 1988 and the ethical rules of Teagasc and the Open University. No personal information will be passed to anyone outside the research team. No individual or invention will be identifiable in published results of the research, unless that is specifically agreed by you.

What if I have other questions?

If you have any other questions about the study, we would be very happy to answer them.

Please contact Trish O'Flynn on 0044 1908 655145 / 7709 xxxxxx or by email to trish.oflynn@open.ac.uk or at The Open University, Department of Engineering and Innovation, Walton Hall, Milton Keynes, MK7 6AA, England. This form is available on request in Irish and other formats, e.g. large print or audio.

Appendix 2 – Content Analysis Coding Manual

This manual is to help you in the coding of farmers' inventions from issues of the magazine. This analysis is intended to produce only descriptive statistics, rather than causal or predictive significance measures.

Each variable is defined according to its use in this study and you should refer only to these definitions while coding your inventions. You may be aware of other definitions of these words, or have previous experience of coding, but only the definitions and codes in this book are applicable here.

Please note: You may have opinions ('It's rubbish/it's brilliant') about aspects of the invention or its use ('That would/would not work on my farm') beyond that contained in the article, but only information that appears in the article is relevant for coding. There is a free text box on the form that you can use for further comments on any aspect of the invention or coding.

1. Completing the Coding Form - Introduction

Unit of analysis: The unit of analysis is a single invention as featured in Practical Farm Ideas magazine.

Coder ID: Fill in your coder identification number.

Invention reference: Fill in the invention's reference number, as indicated on the article copy.

Read the article once, then re-read bearing in mind the variables to be covered.

Invention Description: Give a brief description in your own words of each invention, based on the information supplied in the magazine article, e.g. "adjustable power harrow".

2. Completing the Coding Form - Variables

Mark only one code per variable (except variables 2 and 3).

Variable 1 - Activity – these codes categorise the farming activity to which the invention mainly relates.

101 = Livestock Production and Management (all animals) including:

- Breeding, e.g. heat detection, genetics, insemination, birthing,
- Equipment, e.g. crushes, yokes, feeders,
- Activities, e.g. shearing, feeding (not feedstuffs), moving
- Health & welfare, e.g. treatment/prevention of parasites, injuries, infection, biosecurity.

Excludes:

- Milking, slurry, feedstuffs, bales.
- Working animals e.g. dogs, and companion animals/pets.
- Pest control.
- Animal identification, e.g. ear tags.

102 = Milking:

- all aspects, all animals.

103 = Slurry, including manure, sewage sludge:

- all aspects, e.g. storage, handling, spreading.

104 = Soil and crops, e.g. cereal, grassland, forage, grass and non-grass silage, horticulture, including:

- ploughing, sowing, harrowing, aerating, harvesting;
- seeds and plants;
- preparation, storage and application of fertiliser, pesticide, herbicide etc.,
- grazing,
- soil testing, nutrient/moisture management, growth.

Excluding:

- post-harvest,
- forestry.

105 = Post harvest handling, treatment, storage - any crop (whether from farm or not):

- Includes crops, grains, feedstuffs, bales, clamps.
- Excludes feeding.

106 = Timber/forestry – all aspects.

107 = Farm infrastructure e.g. sheds, workshops, animal housing, gates, fences, roads, water supplies, tanks, stores, drains, hedges.

- Including maintenance, pest control (all aspects but excluding in-field plant protection treatments).

108 = Farm management: e.g. record keeping, ear tags, general oversight.

109 = General Transport: (all aspects not related to specific activity identified above): e.g. maintenance. Includes tractors, trailers, ATVs.

1010 = Waste management: including refuse, yard water, chemicals, carcasses.

- Excludes slurry/manure.

1011 = Environmental protection: e.g. habitats, biodiversity.

1012 = Other: e.g. energy production. Please identify in comments box.

Variables 2: benefits claimed for the invention (only as identified in the article).

Mark all that apply.

201 = Reduce input costs, including multi-purpose.

202 = Save time, more convenient for the farmer.

203 = Increase production, outputs.

204 = Reduce waste, extend life.

205 = Improve process (or part of) or product.

206 = Health & safety (on farm, road etc.)

207 = Environmental.

208 = Animal health & welfare.

209 = Other: please identify in comments box.

Variable 3: Drawbacks (only if identified as drawback in article).

Mark all that apply.

- 301 = Increased costs: e.g. labour, materials, waste.
- 302 = Takes more time.
- 303 = Doesn't work as well as it might.
- 304 = Health and safety issues.
- 305 = Complicated, needs special skills to use/maintain.
- 306 = Other: please identify in comments box below.
- 307 = None identified.

Variable 4: Effect of Invention

These codes describe the degree of creativity and novelty in the invention.

- 401 = incremental, i.e. practical improvement, adaptation, modification, of existing agricultural technologies to improve performance or bring about other benefits.
- 402 = bricolage, i.e. the combination and/or recombination of existing resources at hand (e.g. materials, knowledge, ideas, skills, technologies) to a new purpose, e.g. to solve a problem, or pursue an opportunity.
- 403 = radical, i.e. a whole new way of doing things following a major technological breakthrough, disrupts existing practices.

Variable 5: Use of Existing Knowledge and skills

This refers to the extent to which the farmer-inventor uses their existing experience, skills (e.g. welding, animal handling) and knowledge (e.g. animal behaviour, hydraulics) to create the invention or do they bring in outside help. The code should be selected based on information provided in the article.

Does the farmer-inventor bring in outside help?

501 = Yes

502 = No

Variable 6: Form of invention:

601 = Artefact: physical object e.g. machine, tool, equipment. May be used in a process or part of a process.

602 = Process: a method or a way of performing a task or activity or its constituent steps. May involve artefacts.

Variable 7: Information or Communication Technology, e.g. hardware, software, computer, GPS, etc.

Does the invention use Information or Communication Technology?

701 = Yes

702 = No

Variable 8: Farm sector – indicate the sector in which the invention was made; if mixed farming indicate similarly. If not sure if 801 or 802, use 801. NB Does not indicate sector in which the invention might be used.

- 801 = Cattle: Dairy
- 802 = Cattle: Beef.
- 803 = Sheep.
- 804 = Pig.
- 805 = Poultry (meat/egg).
- 806 = Tillage.
- 807 = Forestry.
- 808 = Other livestock: e.g. deer, goat, equine.
- 809 – Horticulture.
- 810 = Farm contractor, agricultural engineer.
- 811 = Other: please identify in comments box below.
- 812 = None identified

Variable 9: Is the farmer seeking to commercialise their invention, e.g. offers to sell to others, has taken out a patent or other intellectual property protection?

- 901 = Yes
- 902 = No

Variable 10 – Location of Farmer-inventor. The country in which the invention was made.

- 1001 = Rep. of Ireland
- 1002 = England
- 1003 = Wales
- 1004 = Scotland
- 1005 = N. Ireland
- 1006 = Canada
- 1007 = None identified
- 1008 = USA

Variable 11 – year of PFI issue






















- 1101 = 2003
- 1102 = 2008
- 1103 = 2013






























11. Any comments?





Free text box for comments about 'Other' codes, the inventions or the coding scheme.

ENDS

Appendix 3 - Key Informant Interview Guide (Adapted from Laforest et al., 2009, p. 9)

INTRODUCTION OF THE INTERVIEWER		
<p>Hello, my name is Trish O'Flynn and during the interview, I would like to talk to you about: your understanding of farmers' inventions in the Irish context: why they do it, how they go about it, what happens to the inventions. I'll then ask you some specific questions about the role of your organisation and others in offering advice and support to farmer-inventors.</p> <p>With these topics in mind let's start with...</p>		
Main questions	Follow up questions	Clarifying questions
<p><i>Understandings of invention</i></p> <p> What do you understand by farmers' innovations, i.e. things that farmers invent themselves</p>	<p> What experience do you have of farmers' inventions</p> <p> What sort of things do you think of as farmers' inventions</p> <p> Which kind of problems do the inventions address?</p>	<p> Can you expand a little on this?</p> <p> And is there anything else?</p> <p> Can you give me some examples?</p>
<p><i>Manifestations of Invention</i></p> <p> How do you think these inventions come about</p> <p>OR</p> <p> What sort of things do you think of as farmers' inventions</p>	<p> In your experience how common is it in Ireland?</p> <p> Are there particular types of farm enterprise or parts of the country where you might find more inventions</p> <p> Do you ever find that several farmers in one area are inventing?</p>	
<p><i>Farmer inventing behaviours</i></p> <p> In your experience, why do you think farmers invent?</p> <p>OR</p> <p> What motivates farmers to invent?</p>	<p> What triggers farmers to invent?</p> <p> What do they get out of it?</p> <p> Is there something about farmers that makes them inventive?</p> <p> Did you ever come across any women inventors?</p>	
<p><i>Commercialisation of inventions</i></p> <p> Generally speaking, are farmers' inventions brought to the market, commercialised?</p> <p>OR</p>	<p> If not, what are the main issues or problems that might stop farmers bringing inventions to market?</p>	<p></p>

 Do farmers usually want to make money from their inventions?	 How likely are these types of inventions to be successful in the marketplace? If not, why not?  In your experience, how easy is it to make money from an invention?	
<p>Farmer sharing behaviours</p>  There is evidence that some farmers share their inventions or ideas with other farmers for no cost. Is this something you have come across? <p>OR</p>  In your experience, do farmers ever share ideas and inventions between themselves for free?	 How would they go about sharing their invention or ideas?  What, would you say, motivates farmers to share their inventions?  Is recognition from other farmers a motivation do you think?  What do you think about sharing for free rather than making money from their invention?	 Can you expand a little on this?  And is there anything else?  Can you give me some examples?
<p>Help and advice for farmer-inventors</p> <p>Where would a farmer-inventor go for help or advice with inventing</p>  other farmers, neighbours, discussion group  farmers' families  advisers, Teagasc wider community:  your organisation  co-operatives  bank or credit union  IFA/Macra na Feirme	 What is your organisation's role  Is anyone else is involved in designing and making farmers' inventions? E.g. welding, hydraulics, computer  Is there enough help and advice for farmer-inventors in Ireland	
<p>The Inventions – show pics</p>  How do farmers go about making their inventions? <p>OR</p>  In your experience, what is the process from original idea to finished object	 What costs are involved?  Do they use materials at hand or invest in new materials  Do they sometimes have to bring in extra people to make the invention?  How much time is involved?  In making their invention would you say farmers usually tweak or improve something	

	<p>that exists already, OR put together something new</p> <p> How complex are the designs?</p> <p> Are there any particular farm activities, e.g. milking, handling bales, sheds, where farmers invent for more than others?</p>	
CONCLUSION OF INTERVIEW		
<p> Are there any other aspects of farmers' inventions that we have not talked about and that you think are important?</p> <p>OR</p> <p> Do you want to add anything on farmers or their inventions?</p>		

Name of informant:

Role:

Appendix 4 – Information Leaflet for Interview Participants

Teagasc, Rural Economy Research Centre, Athenry,
Galway.

Phone: 091 845270 or 08945 36951

Patricia.oflynn@teagasc.ie

Further information about:

Farmers and Their Inventions: Exploring User Innovation in Agriculture, 2015

What is the aim of this research?

The purpose of this study is to understand the processes and motivators of farmers who invent useful things for the farm. The research will increase awareness of the contribution farmers' inventions can make to agriculture and the economy as this is not well understood at the moment. The study looks at the types of inventions, how farmers go about developing their ideas, the benefits claimed, how the ideas are shared and with whom. Teagasc and the UK Open University jointly fund this study.

Who is conducting the research and who is it for?

Trish O'Flynn is a PhD research student carrying out this research on behalf of Teagasc and the Open University. She has received training in carrying out research on agricultural innovation. We design, carry out, and analyse research in the field of agriculture and further information about us can be found on our websites: www.teagasc.ie and www.open.ac.uk.

Why am I being invited to participate in this research?

You have been identified as farmer who has invented something new. For this reason, we would like to invite you to participate in our research.

If I take part in this research, what will be involved?

We will be conducting interviews during 2015. The interviews will take approximately two hours and would be conducted at your farm, or another location if you prefer, at a date and time that is convenient to you. To ensure your safety, our researcher carries photo identification.

What will the interview be like?

In the interview, you will talk to Trish about your invention. She will make notes as you speak and you will be asked if you are willing to be audio-recorded or video-recorded so that the interview can be written up word-for-word later. If you have any papers or photos of your invention that you would like to show Trish that would be helpful. You will be asked to give your formal consent to being interviewed and you can have a copy of the interview later.

What will we be talking about?

Trish will be asking you to tell the story of your invention. For example, where your idea came from, what you were trying to achieve, how you went about designing and developing your idea, if you commercialised your idea or shared it with anyone, and how.

Is it confidential?

Yes. Your participation will be treated in **strict confidence** in accordance with the UK Data Protection Act 1988 and the ethical rules of Teagasc and the Open University. No personal information will be passed to anyone outside the research team. We will write a report of the findings from this study, but no individual or invention will be identifiable in published results of the research, unless that is specifically agreed by you.

What happens now?

Your participation is entirely voluntary, you can withdraw at any time up to the point where data is processed (approximately November 2015). If you would like to take part then please let Trish O'Flynn know (her contact details are below). She can answer any questions you may have about the research and will arrange a date and time to interview you.

What if I have other questions?

If you have any other questions about the study, we would be very happy to answer them.

Please contact Trish O'Flynn on 091 845289 or 08945 xxxxx or by email to Patricia.oflynn@teagasc.ie. This form is available on request in Irish and other formats, e.g. large print or audio.

Appendix 5 - Consent Form for Interview Participants

Farmers and Their Inventions: Exploring User Innovation in Agriculture

I confirm that I have read and understood the information sheet supplied to me for the above research. I have had time to consider the information, ask questions and have had these answered satisfactorily.

I understand that I am free to withdraw up to the point when data is processed (approximately November 2015) without giving any reason.

I understand that my name will not appear in any reports, articles or publications, unless specifically agreed.

I understand that information I give to the researcher may be quoted or used anonymously as an example in reports, articles or presentations.

I understand that details of my invention will not appear in any reports, articles or presentations, unless specifically agreed.

I agree to the interview/observation being audio-recorded or video-recorded (delete as applicable). I understand it will be written out word-for-word later and I may request a copy of the transcript.

I understand that my participation is voluntary and I agree to take part in the above study.

I would like to receive updates on the project and a copy of the report. Please give contact details overleaf.

Name of participant:

Signature of participant

Date:

Signature of researcher

Date:

Participant contact details:

Address

Contact numbers

Email

For further information, please contact:

Trish O'Flynn, Rural Economy Research Centre, Teagasc, Mellows Campus, Athenry, Galway.

Phone: 091 845270 or 08945 -----

Email: Patricia.oflynn@teagasc.ie

This form is available on request in Irish and other formats, e.g. large print or audio.

REFERENCES

- Ackoff, R. (2001) 'OR: after the post mortem', *System Dynamics Review*. 17 (4). pp. 341–346.
- Adkins, L. (2005) 'Social capital: the anatomy of a troubled concept', *Feminist Theory*, 6(2), pp.195-211.
- Alexandratos, N., & Bruinsma, J. (2012) *World agriculture towards 2030/2050: the 2012 revision*. ESA Working Paper 12-03. Rome: FAO.
- Amin, A. and Roberts, J. 2008) 'Knowing in action: Beyond communities of practice', *Research Policy*, 37(2), pp. 353-369.
- Anderson, C. (2012) *Makers: The New Industrial Revolution*. Random House: London.
- Andrew, N., Tolson, D. and Ferguson, D. (2008) 'Building on Wenger: Communities of Practice in Nursing', *Nurse Education Today*, 28(2), pp. 246-252.
- Aoki, K. (2009) "'Free Seeds, Not Free Beer": Participatory Plant Breeding, Open Source Seeds, and Acknowledging User Innovation in Agriculture', *Fordham Law Review*, 77, pp. 2275-2310.
- Arenius P, and M. Minniti (2005) 'Perceptual Variables and Nascent Entrepreneurship', *Small Business Economics*, 24(3), pp. 233-247.
- Atkinson, P. and Coffey, A. (2011) 'Analysing Documentary Realities', in Silverman, D. (ed.) *Qualitative Research: Issues of Theory, Method and Practice*. 3rd edn. London: SAGE.
- Baker, T. and Nelson, R. (2005) 'Creating Something from Nothing: Resource Construction through Entrepreneurial Bricolage', *Administrative Science Quarterly*. 50, pp. 329-366.
- Barnes, A., Toma, L., Willock, J. and Hall, C. (2013) 'Comparing a 'budge' to a 'nudge': Farmer responses to voluntary and compulsory compliance in a water quality management regime', *Journal of Rural Studies*. 32, pp. 448–459.
- Becker, H. (1970). 'Field work evidence' in H. Becker, *Sociological work: Method and substance*. New Brunswick, NJ: Transaction Books. pp. 39-62.
- Bellon, M.R. (2001) *Participatory Research Methods for Technology Evaluation: A Manual for Scientists Working With Farmers*. Mexico: CIMMYT.
- Bentley, J. (2006) 'Folk experiments', *Agriculture and Human Values*. 23. pp: 451–462.
- Bentley, J., Van Mele, P. and Acheampong, G. (2010) 'Experimental By Nature: Rice Farmers in Ghana', *Human Organization*. 69(2) pp. 129-137.
- Berdegué, J.A. (2005) 'Pro-Poor Innovation Systems', background paper. Rome: International Foundation for Agricultural Development (IFAD). Available at: <http://www.ifad.org/events/gc/29/panel/e/julio.pdf> (Accessed 21.7.17).
- Bergevoet, R. and Van Woerkum, C. (2006) 'Improving the Entrepreneurial Competencies of Dutch Dairy Farmers through the Use of Study Groups', *The Journal of Agricultural Education and Extension*, 12(1), pp. 25-39.

- Biniari, M. (2012) 'The emotional embeddedness of corporate entrepreneurship: the case of envy', *Entrepreneurship Theory and Practice*, 36(1), pp. 141-170.
- Blackmore, C. (2007) 'What kinds of knowledge, knowing and learning are required for addressing resource dilemmas?: a theoretical overview', *Environmental Science & Policy*, 10 (6), pp. 512-525.
- Bock, B. (2015) 'Social innovation – a solution for marginalising rural areas?', paper presented at XXVI European Society for Rural Sociological Congress, Aberdeen, Scotland, 18-21 August.
- Bogers, M., Afuah, A. and Bastian, B. (2010) 'Users as innovators: a review, critique, and future research directions', *Journal of Management*, 36 (4), pp. 857-875.
- Bogers, M. and West, J. (2012) 'Managing Distributed Innovation: Strategic Utilization of Open and User Innovation', *Creativity and Innovation Management*, 21 (1) pp. 61-75.
- Bonanno, A. and Constance, D.H. (2001) 'Globalization, Fordism, and Post-Fordism in Agriculture and Food: A Critical Review of the Literature', in *Culture & Agriculture*, 23 (2), pp.1-18.
- Bourdieu, P.
- (1990) *The Logic of Practice*. Cambridge: The Polity Press.
- (1986) 'Three Forms of Capital', in Richardson, J. G. (ed.) *Handbook of Theory and Research for the Sociology of Education*. New York: Greenwood Press. pp. 241-258.
- Bourke, B. (2014) 'Positionality: Reflecting on the research process', *The Qualitative Report*, 19 (33), pp. 1-9.
- Boyle, G. (2012) 'Enhancing Irish Agricultural Productivity through Technology Adoption: A Critique of the Irish Agricultural Knowledge and Innovation System (AKIS)', in Heanue, K., Macken-Walsh, A., and Maher, P. (Eds.) *Teagasc Best Practise in Extension Services - Supporting Farmer Innovation*. Dublin: Teagasc. pp. 1-6.
- Brandth, B. and Haugen, M (2011) 'Farm diversification into tourism - Implications for social identity?' *Journal of Rural Studies* (27) pp. 35-44.
- Braun, A., Thiele, G. and Fernández, M. (2000) 'Complementary platforms for farmer innovation', ILEIA Newsletter.
- Braun, V. and Herstatt, C. (2007) 'Barriers to user innovation: moving towards a paradigm of 'licence to innovate'?' *International Journal of Technology, Policy and Management*, 7 (3), 292-303.
- Briscoe, G. and Mulligan, C. (2014) *The Hackathon Phenomenon*. Available at: <https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwj4pqGhgJvVAhWsKsAKHaMND3gQFggnMAA&url=http%3A%2F%2Fwww.creativeworkslondon.org.uk%2Fwp-content%2Fuploads%2F2013%2F11%2FDigital-Innovation-The-Hackathon-Phenomenon1.pdf&usg=AFQjCNGyUFGzYs-4YL8S5Kew59XnyrU8SQ> (Accessed 15.6.17).

British Sociological Association (2002) *Statement of ethical practice*. Available at: <https://www.britisoc.co.uk/equality-diversity/statement-of-ethical-practice/> (Accessed 21.7.17).

Brown, T. (1985) *Ireland, a Social and Cultural History 1922-1985*. London: Fontana Press.

Bruckmeier, K. and Tovey, H. (2008) 'Knowledge in Sustainable Rural Development: From Forms of Knowledge to Knowledge Processes', *Sociologia Ruralis*, 48 (3), pp. 313-329.

Bryant, L. and Garnham, B., 2014. Economies, ethics and emotions: Farmer distress within the moral economy of agribusiness. *Journal of Rural Studies*, 34, pp.304-312.

Bryman, A. (2012) *Social research methods*. 4th edn. Oxford: Oxford University Press.

Burton, R.

(2012) 'Understanding Farmers' Aesthetic Preference for Tidy Agricultural Landscapes: A Bourdieusian Perspective', *Landscape Research*, 37 (1) pp. 51-71.

(2004) 'Seeing Through the 'Good Farmer's' Eyes: Towards Developing an Understanding of the Social Symbolic Value of 'Productivist' Behaviour', *Sociologia Ruralis*, 44 (2), pp. 195-215.

Burton, R., Kuczera, C. and Schwarz, G. (2008) 'Exploring Farmers' Cultural Resistance to Voluntary Agri-environmental Schemes', *Sociologia Ruralis*, 48 (1), pp. 16-37.

Burton, R. and Wilson, G. (2006) 'Injecting social psychology theory into conceptualisations of agricultural agency: Towards a post-productivist farmer self-identity?' *Journal of Rural Studies*, 22 (1), pp. 95-115.

Butler, J. (1988) 'Performative acts and gender constitution', *Theatre Journal*, 40 (4), pp. 519-531.

Byrne, A. & O'Mahony, D. (2012) 'Family and Community: (Re)Telling Our Own Story', *Journal of Family Issues*, 33(1), pp. 52-74.

Cardon, M.S., Wincent, J., Singh, J. and Drnovsek, M. (2009) 'The nature and experience of entrepreneurial passion', *Academy of Management Review*, 34(3), pp.511-532.

Cardona, A. and Tomancak, P. (2012) 'Current challenges in open-source bioimage informatics', *Nature Methods*, 9 (7), pp. 661-665.

Cassidy, A. and McGrath, B. (2015) 'Farm, place and identity construction among Irish farm youth who migrate', *Journal of Rural Studies*, 37, pp.20-28.

Chamberlayne, P. (2005) *Comparative analysis of cases—using the biographic-narrative interpretive method (BNIM)*. Available at: <http://eprints.ncrm.ac.uk/12/1/PrueChamberlayne-ComparativeAnalysis.pdf> (Accessed 1.7.16).

Chambers, R. (2002) *Participatory workshops: a sourcebook of 21 sets of ideas and activities*. London, Earthscan/James and James.

- Chesbrough, H., Vanhaverbeke, W., and West, J. (2006) *Open Innovation: Researching a New Paradigm*, Oxford: Oxford University Press.
- Chiswell, H. and Wheeler, R. (2016) "'As long as you're easy on the eye": reflecting on issues of positionality and researcher safety during farmer interviews', *Area*, 48 (2), pp. 229–235.
- Clark, N., Frost, A., Maudlin, I. and Ward, A. (2013) *Technology Development Assistance for Agriculture: Putting Research into Use in Low Income Countries*. Routledge: Abingdon
- Coakley, J. (2009) 'Society and Political Culture', in Coakley, J and Gallagher, M (eds.) *Politics in the Republic of Ireland*. 5th edn. Routledge Ltd [online] pp. 37-71.
- Coghlan, D. and Brannick, T. (2005) *Doing Action Research in your own Organisation*. 2nd edn. London: SAGE Publications Ltd.
- Collins, K. (2014) 'Designing Social Learning Systems for Integrating Social Sciences into Policy Processes: Some Experiences of Water Managing', in M.J. Manfredo et al. (eds.), *Understanding Society and Natural Resources*. pp. 229-251. Springer Open. Available at: https://link.springer.com/chapter/10.1007%2F978-94-017-8959-2_11 (Accessed 21.7.17).
- Cowan, R., David, P. and Foray, D (2000), "The explicit economics of knowledge codification and tacitness", *Industrial and Corporate Change*. 9 (2) pp. 211-253.
- Creswell, J., Klassen, A., Plano Clark, V. and Smith, K. (2011) *Best practices for mixed methods research in the health sciences*, Bethesda, MD: National Institutes of Health, 10. Available at: https://www.nursing.virginia.edu/media/Best_Practices_for_Mixed_Methods_Research.pdf (Accessed 21.7.17).
- Critchley, W. (ed.) (1999) *Promoting Farmer Innovation: Harnessing local environmental knowledge in East Africa*. UNDP – Office to Combat Desertification and Drought (UNSO/SEED/BDP), and SIDA's Regional Land Management Unit (RELMA). Available at: <http://www.pnud.org.ar/content/dam/undp/library/Environment%20and%20Energy/sustainable%20land%20management/Promoting%20Farmer%20Innovation%20-%20Harnessing%20local%20environmental%20knowledge%20in%20East%20Africa.pdf> (Accessed 8.7.17).
- Critchley, W.R.S. and Mutunga, K. (2003) 'Local innovation in a global context: documenting farmer initiatives in land husbandry through WOCAT', *Land Degradation & Development*. 14(1), pp.143-162.
- Crowley, E. (2006) *Land Matters: Power Struggles in Rural Ireland* Dublin: The Lilliput Press.
- Curry, N., Ingram, J., Kirwan, J. and Maye, D. (2012) 'Knowledge networks for sustainable agriculture in England', *Outlook on AGRICULTURE*. 41 (4) pp. 243–248.
- Cush, P. and Macken-Walsh, Á. (2016) 'The Potential for Joint Farming Ventures in Irish Agriculture: A Sociological Review', *European Countryside*. 8(1), pp.33-48.
- Davis, K. (2008) 'Extension in sub-Saharan Africa: Overview and assessment of past and current models and future prospects', *Journal of International Agricultural and Extension Education* 15(3) pp. 15-28.

Davis, K., Franzel, S., Hildebrand, P., Irani, T. and Place, N. (2004) 'Extending technologies among small-scale farmers in Meru, Kenya: Ingredients for success in farmer groups', *The Journal of Agricultural Education and Extension*. 10(2), pp. 53-62.

Denzin, N. (2012) 'Triangulation 2.0', *Journal of Mixed Methods Research*. 6(2) pp. 80–88.

Dieffenbach, E.M. and Gray, R.B. (1960) 'The development of the tractor', *Agricultural Yearbook, 1960*, pp.24-45.

Dolma, S. (2010) 'The central role of the unit of analysis concept in research design', *Istanbul University Journal of the School of Business Administration*. 39 (1), pp. 169-174.

de Dominicis, L., Florax, R. and de Groot, H. (2013) 'Regional clusters of innovative activity in Europe: are social capital and geographical proximity key determinants?', *Applied Economics*. 45, pp. 2325–2335.

Donovan, M. (2014) Skype call with Trish O'Flynn, 2 October.

Duesberg, S., O'Connor, D. and Ní Dhubháin, Á. (2013) 'To plant or not to plant - Irish farmers' goals and values with regard to afforestation', *Land Use Policy* 32 pp. 155– 164.

Duguid, P. (2005) "'The Art of Knowing": Social and Tacit Dimensions of Knowledge and the Limits of the Community of Practice', *Information Society*, 21 (2), pp. 109-118.

Dutfield, G. (2006) *Protecting Traditional Knowledge: Pathways to the Future*. Geneva: ICTSD.

Eastwood, C., Chapman, D. and Paine, M. (2012) 'Networks of practice for co-construction of agricultural decision support systems: Case studies of precision dairy farms in Australia', *Agricultural Systems*, 108, pp. 10-18.

Ellingson, L. (2014) "'The truth must dazzle gradually": Enriching relationship research using a crystallization framework', *Journal of Social and Personal Relationships*. 31(4) pp. 442–450.

Emtage, N., Herbohn, J. and Harrison, S. (2007). 'Landholder profiling and typologies for natural resource–management policy and program support: potential and constraints', *Environmental Management* 40(3) pp. 481-492.

European Commission

(2016c) *A Strategic Approach to EU Agricultural Research & Innovation: A Final Paper*. Available at: <https://ec.europa.eu/programmes/horizon2020/en/news/final-paper-strategic-approach-eu-agricultural-research-and-innovation> (Accessed 1.7.17).

(2016b) *Productivity in EU Agriculture - Slowly But Steadily Growing*. EU Agricultural Markets Briefs, 10. Available at: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwi-pObqo5vVAhXnDcAKHTxVAocQFggoMAA&url=https%3A%2F%2Fec.europa.eu%2Fagriculture%2Fsites%2Fagriculture%2Ffiles%2Fmarkets-and-prices%2Fmarket-briefs%2Fpdf%2F10_en.pdf&usg=AFQjCNEpshue-5DmJBsKnX5p52L6qbEMRQ (Accessed 6.7.17)

(2016a) *CAP Expenditure in the Total EU Expenditure*. Available at: https://ec.europa.eu/agriculture/graphs-figures/cap_en (Accessed 11.3.17)

(2015b) *User Guide to the SME Definition*. Available at: http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en (Accessed 9.7.17)

(2015a) *EU Agricultural Outlook: Prospects for EU Agricultural Markets and Income 2015-2025*. Available at: https://ec.europa.eu/agriculture/markets-and-prices/market-statistics_en (Accessed 9.7.17)

(2014) *Agriculture in the European Union: Markets Statistical Information*. Available at: https://ec.europa.eu/agriculture/markets-and-prices/market-statistics_en (Accessed 6.6.17)

(2013) *Overview of Cap Reform 2014-2020*. Agricultural Policy Perspectives Brief (5). Available at: http://ec.europa.eu/agriculture/policy-perspectives/policy-briefs/05_en.pdf (Accessed 12.7.17)

(2012) *Commission Staff Working Document: A View on Employment, Growth and Innovation in Rural Areas*. Available at: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0ahUKEwjknITHopvVAhXqDMAKHYGxA9MQFgg1MAI&url=https%3A%2F%2Fwww.coiaanpv.org%2Frecursos%2Fagent.php%3Frepository_id%3D1%26resource_id%3D1989&usg=AFQjCNEfuFc0ApQ3hE7bH7HfLgU0-YdN8w (Accessed 8.7.17).

European Union Standing Committee on Agricultural Research (EU SCAR)

(2016) *Agricultural Knowledge and Innovation Systems Towards the Future – a Foresight Paper*, Brussels.

(2013) *Agricultural Knowledge and Innovation Systems Towards 2020 – an Orientation Paper on Linking Innovation and Research*, Brussels.

(2012) *Agricultural Knowledge and Innovation Systems in Transition – a reflection paper*. Brussels.

Eurostat

(2016) *Agriculture, forestry and fishery statistics, 2015 edition*. Luxembourg: Publications Office of the European Union.

(2015) *Agriculture, forestry and fishery statistics, 2014 edition*. Luxembourg: Publications Office of the European Union.

(2014) *Agri-environmental indicator - farmers' training and environmental farm advisory services*. Luxembourg: Publications Office of the European Union.

Fagerberg, J. (2003) 'Innovation: a guide to the literature', paper to be presented at "The Many Guises of Innovation: What we have learnt and where we are heading" Workshop. Ottawa, 23-24 October.

Farm Hack website: <http://farmhack.net/home/> (Accessed 8.7.17)

Farrell, M., McDonagh, J. and Mahon, M. (2008) *Agricultural Extension Advisory Services: The Challenge of Implementing a Multifunctional Advisory Programme*. Teagasc RERC Working Paper Series. Available at: https://www.academia.edu/9705887/Agricultural_Extension_Advisory_Services_The_Challenge_of_Implementing_a_Multifunctional_Advisory_Programme (Accessed 8.7.17).

Fauchart, E. and von Hippel, E. (2008) 'Norms-Based Intellectual Property Systems: The Case of French Chefs', *Organization Science*. 19(2), pp. 187–201.

Faure, G., Desjeux, Y. and Gasselin, P. (2012) 'New Challenges in Agricultural Advisory Services from a Research Perspective: A Literature Review, Synthesis and Research Agenda', *The Journal of Agricultural Education and Extension* 18(5), pp. 461-492.

Finland: Ministry of Employment and the Economy (2015) *Inspiring Innovation – Meeting the Necessity for Renewal*. Available at: <http://julkaisut.valtioneuvosto.fi/handle/10024/74963> (Accessed 12.7.17).

Flowers, S., von Hippel, E., de Jong, J. and Sinozic, T. (2010) *Measuring User Innovation in the UK: The Importance of Product Creation by Users*. NESTA: London.

Flyvbjerg, B. (2011) 'Case Study', in Denzin, N. and Lincoln, Y. (eds.) *The Sage Handbook of Qualitative Research*, 4th Edn. Sage: Thousand Oaks. pp. 301-316.

Franke, N., Von Hippel, E. & Schreier, M. (2006) 'Finding commercially attractive user innovations: A test of lead-user theory'. *Journal of Product Innovation Management*, 23(4), pp. 301-315.

Franz, N. (2013) 'The data party: Involving stakeholders in meaningful data analysis', *Journal of Extension*, 51(10), 11AW2.

Galt, R. (2013) 'From *Homo economicus* to Complex Subjectivities: Reconceptualizing Farmers as Pesticide Users', *Antipode*. 45 (2) pp. 336–356.

Garud, R. (1997) 'On the distinction between know-how, know-what and know-why', *Advances in Strategic Management*, 14, pp. 81-101.

Garud, R. and Karnøe, P. (2003) 'Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship', *Research Policy*. 32, pp. 277 - 300.

Gasson, R. (1973) Goals and values of farmers. *Journal of Agricultural Economics*, 24, pp. 521–542.

Gaventa, J. and Cornwall, A. (2001) 'Power and Knowledge', in Reason, P., and Bradbury, H. (Eds.). (2001). *Handbook of Action Research: Participative Inquiry and Practice*. London: Sage Publications. pp. 70-80.

Genat, B. (2009) 'Building emergent situated knowledges in participatory action research' in *Action Research*. 7 (1) pp. 101–115.

Gergs, H. (2003) 'Economic, Social, and Symbolic Capital: New Aspects for the Development of a Sociological Theory of the Market', *International Studies of Management & Organisation*. 33 (2), pp. 22–48.

- Górecki, M. and Marsh, M (2014) 'A decline of 'friends and neighbours voting' in Ireland? Local candidate effects in the 2011 Irish 'earthquake election', *Political Geography*, 41, pp. 11-20.
- Granovetter, M. (1973) 'The strength of weak ties', *American Journal of Sociology*, 78 (6), pp. 1360-1380.
- Hall, A., Sulaiman, V., Clark, N. and Yoganand, B. (2003) 'From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research', *Agricultural Systems*, 78(2), pp. 213-241.
- Hall, A., Mytelka, L. and Oyeyinka, B. (2006) *Concepts and guidelines for diagnostic assessments of agricultural innovation capacity*, UNU-MERIT Working Paper Series 2006-017. Available at: <https://www.merit.unu.edu/publications/wppdf/2006/wp2006-017.pdf> (Accessed 8.7.17)
- Hardiman, N., McCashin, T. and Payne, D. (2004) 'Understanding Irish attitudes to poverty and wealth', *Dublin: Institute for the Study of Social Change*. Available at: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjKuLvxiJvVAhUHL8AKHb4TAuQQFggtMAA&url=http%3A%2F%2Ffirserver.ucd.ie%2Fbitstream%2Fhandle%2F10197%2F1888%2FISSCWP200409.pdf%3Fsequence%3D1&usg=AFQjCNFK-Xu-wxNuvD-4KaY8BU_tnV7k0w (Accessed 12.7.17).
- Henchion, M., O'Reilly, P., Kelly, D., and Buckley, M. (2009) *Improving Technology Transfer and Research Commercialisation in the Irish Food Innovation System*. Ashtown Food Research Centre Report 104, Teagasc.
- Henderson, R.M. and Clark, K.B. (1990) 'Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms', *Administrative Science Quarterly*, 35 (1), pp.9-30.
- Henkel, J., Stiegler, A. and Block, J. 'Selling to Competitors? Competitive Implications of User-Manufacturer Integration' in Harhoff, D. and Lakhani, K. (eds.) (2016) *Revolutionizing Innovation: Users, Communities, and Open Innovation*. Cambridge, Massachusetts: The MIT Press, p. 379-396.
- Henkel, J. and von Hippel, E. (2003) 'Welfare implications of user innovation', *MIT Sloan School of Management Working Papers*. No. 4327-03.
- Hennessy, T. and Moran, B.
- (2016) *The Viability of the Irish Farming Sector in 2015*. Available at: https://www.teagasc.ie/media/website/publications/2016/Viability-Analysis_2015.pdf (Accessed 30.6.17).
- (2015) Teagasc National Farm Survey: 2014 Results. Available at: https://www.teagasc.ie/media/website/publications/2015/NFS2014_final_report.pdf (Accessed 30.6.17).
- Hiennerth, C., Lettl, C. and Keinz, P. (2014) 'Synergies among producer firms, lead users, and user communities: The case of the LEGO producer-user ecosystem', *Journal of Product Innovation Management*, 31 (4), pp. 848-866.

HM Government (2013) *A UK Strategy for Agricultural Technologies*. Available from <https://www.gov.uk/government/collections/agricultural-technologies-agri-tech-strategy> (Accessed 8.7.17).

Hoffmann, V., Probst, K. and Christinck, A. (2007) 'Farmers and researchers: How can collaborative advantages be created in participatory research and technology development?', *Agriculture and Human Values* 24. pp. 355–368.

Holliday, A. (2002) *Doing and Writing Qualitative Research*. London: SAGE Publications Ltd.

Honeybee Network website: <http://www.sristi.org/hbnew/index.php> (Accessed 8.7.17).

Howard, T., Culley, S., and Dekoninck, E. (2008) 'Describing the creative design process by the integration of engineering design and cognitive psychology literature', *Design Studies*, 29, pp. 160-180.

Howells, J.R. (2002) 'Tacit Knowledge, Innovation and Economic Geography', *Urban Studies*, 39 (5-6) pp. 871–884.

Hunt, L., Rosin, C., Campbell, H. and Fairweather, J. (2013) 'Turning farms into businesses: Some unexpected consequences of neoliberalism for New Zealand farmers', *New Zealand Agricultural and Resource Economics Society*, August 28-30, Christchurch, New Zealand.

Ingram, J. (2010) 'Technical and social dimensions of farmer learning: an analysis of the emergence of reduced tillage systems in England', *Journal of Sustainable Agriculture*. 34(2), pp.183-201.

Ingram, J., Maye, D., Kirwan, J., Curry, N. and Kubinakova, K. (2014) 'Learning in the permaculture community of practice in England: an analysis of the relationship between core practices and boundary processes'. *The Journal of Agricultural Education and Extension*, 20 (3), pp.275-290.

Innovative Farmers website. Available at: <https://www.innovativefarmers.org/> (Accessed 22.7.17).

Ireland: Department of Agriculture, Food and the Marine (DAFM)

(2016) *Helpsheet / Terms & Conditions for the 2016 EU Basic Payment Scheme (BPS)/Greening Payment and Other 2016 Area-Based Schemes*. Available at: <http://www.agriculture.gov.ie/media/migration/farmingschemesandpayments/basicpaymentscheme/2016forms/TermsConditions2016EUBasicPaymentSchemeGreeningPayment.pdf> (Accessed 12.7.17)

(2015) *Food Wise 2025: A vision for growth for the Irish agricultural economy for the next 10 years*. Available at: <https://www.agriculture.gov.ie/foodwise2025/> (Accessed 7.7.17).

Ireland: Department of the Environment, Community, and Local Government (2015) *Summary of Rural Development Programme Ireland 2014–2020*. Available at: <https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwj57uveppvVAhWJDMAKHsKiABYQFggoMAA&url=https%3A%2F%2Fwww.agriculture.gov.ie%2Fmedia%2Fmigration%2Fralenvironment%2Fraldevelopment%2Fraldevelopmentprogramme2014->

[2020%2FSummaryBookletSept16290916.pdf&usg=AFQjCNHvwD2FsX0MKokc1yix589KHlpXHw](#)
(Accessed 12.7.17).

Ison, R. (2008) 'Methodological challenges of trans-disciplinary research: some systemic reflections', *Natures Sciences Sociétés*. 16, pp. 241-251.

Ison, R. and Collins, K. (2008) 'Public policy that does the right thing rather than the wrong thing righter', in *Analysing Collaborative and Deliberative Forms of Governance*, 14 Nov 2008, The Australia National University, Canberra, Australia.

Ison, R.L., Collins, K.B. and Wallis, P.J. (2015) 'Institutionalising social learning: Towards systemic and adaptive governance', *Environmental Science & Policy*, 53, pp.105-117.

Ison, R.L., Steyaert, P., Roggero, P., Hubert, B. and Jiggins, J. (2004) *The SLIM (Social learning for the integrated management and sustainable use of water at catchment scale) Final Report*. Available at: <http://oro.open.ac.uk/2839/> (Accessed 28.6.17).

James, N. and Gudmundsson, A. (2011) 'Exploring the impact of entrepreneur optimism on the new venture process', In Maritz, A. (Ed.) *Proceedings of the 8th AGSE International Entrepreneurship Research Exchange*, Swinburne University of Technology, Melbourne, Victoria. pp. 1375-1384.

Johnson, B. and Lundvall, B. (2001) 'Why all this fuss about codified and tacit knowledge?', DRUID Winter Conference January 18-20 2001, Aalborg University.

de Jong, J. 'The Empirical Scope of User Innovation' in Harhoff, D. and Lakhani, K. (eds.) (2016) *Revolutionizing Innovation: Users, Communities, and Open Innovation*. Cambridge, Massachusetts: The MIT Press, pp. 67-87.

de Jong, J. and von Hippel, E. (2008) 'User innovation in SMEs: incidence and transfer to producers', Working Paper H200814. Available at: <http://ondernemerschap.panteia.nl/pdf-ez/h200814.pdf> (Accessed 20.7.17)

de Jong, J., von Hippel, E., Gault, F., Kuusisto, J. and Raasch, C. (2015) 'Market failure in the diffusion of consumer-developed innovations: Patterns in Finland'. *Research Policy*, 44 (10), pp.1856-1865.

Jörg, T. and Akkaoui Hughes, S. (2013) 'Architecting the Dynamics of Innovation', in *Proceedings of the International Conference on Intellectual Capital*, Bilbao, Spain. 11-12 April 2013, pp. 222-230. Available at: <http://connection.ebscohost.com/c/articles/87423229/architecting-dynamics-innovation> (Accessed 8.7.17)

Joshi, S., Jochen P. and Valkenburg, P. (2011) 'Scripts of Sexual Desire and Danger in US and Dutch Teen Girl Magazines: A Cross-National Content Analysis', *Sex Roles: A Journal of Research*. Available at: <http://rd.springer.com/article/10.1007/s11199-011-9941-4/fulltext.html> (Accessed 8.7.17).

Kassarjian, H. (1977) 'Content Analysis in Consumer Research', in *The Journal of Consumer Research*, 4 (1), pp. 8-18.

Katila, S. (2002) 'Emotions and the moral order of farm business families in Finland', in Fletcher, D. (ed.) *Understanding the small family business* [Online], Routledge: London. pp.180 - 214.

Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1511521 (Accessed 16.7.17).

Kaufman, I.R. (1958) 'Masters in the Federal Courts: Rule 53'. *Columbia Law Review*, 58(4), pp.452-469.

Kebede, B. and Zizzo, D.J. (2011) 'Envy and agricultural innovation: An experimental case study from Ethiopia' *Centre for the Study of African Economics Working Paper Series*, WPS/2011-06. (Available at: <https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwui1Znyp5vVAhXslsAKHUwRCT8QFggrMAA&url=https%3A%2F%2Fwww.csae.ox.ac.uk%2Fworkingpapers%2Fpdfs%2Fcsae-wps-2011-06.pdf&usq=AFQjCNG80RqgvMdtjxSE68nR0V0aljgZzw> (Accessed 16.7.17).

Kilelu, C., Klerkx, L. and Leeuwis, C. (2013) 'Unravelling the role of innovation platforms in supporting co-evolution of innovation: contributions and tensions in a smallholder dairy development programme', *Agricultural systems*. 118, pp.65-77.

King, A. (2000) 'Thinking with Bourdieu against Bourdieu: A 'practical' critique of the habitus', *Sociological theory*, 18(3), pp. 417-433.

Kiptot, E., Franzel, S., Hebinck, P. and Richards, P. (2006) 'Sharing seed and knowledge: farmer to farmer dissemination of agroforestry technologies in western Kenya', *Agroforest Systems*. 68, pp. 167–179.

Kirby, P. (2010) *Celtic Tiger in Collapse (2nd edn.)* Basingstoke: Palgrave MacMillan.

Kitching, J. and Blackburn, R. (1998), 'Intellectual property management in the small and medium enterprise (SME)', in *Journal of Small Business and Enterprise Development*, 5 (4). pp. 327 – 335.

Klerkx, L. and Proctor, A. (2013) 'Beyond fragmentation and disconnect: Networks for knowledge exchange in the English land management advisory system', *Land Use Policy* 30, pp. 13– 24.

Kline, R. and Pinch, T. (1996) 'Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States', *Technology and Culture*, 37 (4), pp. 763-795.

Knickel, K., Brunori, G., Rand, S., and Proost, J. (2009) 'Towards a better conceptual framework for innovation processes in agriculture and rural development: from linear models to systemic approaches', *Journal of Agricultural Education and Extension*, 15(2), pp. 131-146.

Krippendorff, K. (2004). Reliability in Content Analysis: Some Common Misconceptions and Recommendations, in *Human Communication Research*, 30 (3), pp. 411-433.

Labarthe, P., Caggiano, M., Laurent, C., Faure, G. and Cerf, M. (2013) 'Concepts and theories available to describe the functioning and dynamics of agricultural advisory services'. PRO AKIS deliverable 2. Available at:

[http://www.proakis.eu/sites/www.proakis.eu/files/Deliverable_WP2%201_concepts%20and%20theories%20of%20AKIS\(1\).pdf](http://www.proakis.eu/sites/www.proakis.eu/files/Deliverable_WP2%201_concepts%20and%20theories%20of%20AKIS(1).pdf) (Accessed 20.7.17)

Laforest, J., Bouchard, L. and Maurice, P. (2009) *Guide to Organizing Semi-structured Interviews with Key Informants: Safety Diagnosis Tool Kit for Local Communities*. Quebec: Institut National

de Santé Publique. Available at: <https://www.inspq.qc.ca/en/publications/1004> (Accessed 8.7.17).

Lane, A. (2002) *Systems Thinking and Practice: A Primer*. Milton Keynes: The Open University

Lane, A. and Oreszczyn, S. (2013). 'Understanding influences on farmers' practices', in *Sustainable Intensification: The pathway to low carbon farming?* 25-27 September, Edinburgh, pp. 41–43.

Lane, J. and Flagg, J. (2010) 'Translating three states of knowledge—discovery, invention, and innovation', *Implementation Science* 5 (9).

Lansing, J. S., and Miller, J. (2005) 'Cooperation, Games, and Ecological Feedback: Some Insights from Bali', *Current Anthropology*, 46(2), 328–334.

Läpple, D. and Kelley, H. (2013) 'Understanding the uptake of organic farming: Accounting for heterogeneities among Irish farmers', *Ecological Economics*. 88, pp. 11–19.

Lettl, C., Herstatt, C. and Gemuenden, H. (2006) 'Users' contributions to radical innovation: evidence from four cases in the field of medical equipment technology', *R&D Management*, 36 (3), pp.251-272.

Lévi-Strauss, C. (1966) *The Savage Mind*. Oxford: Oxford University Press.

Levidow, L. (2011) *Agricultural Innovation: Sustaining What Agriculture? For What European Bio-Economy?* Available at: <http://crepeweb.net/?m=201102> (Accessed 8.7.17).

Levidow, L. and Papaioannou, T. (2010) *Innovation narratives in European agricultural research*. Available at: http://crepeweb.net/?page_id=442 (Accessed 8.7.17).

Lilien, G., Morrison, P., Searls, K., Sonnack, M. and von Hippel, E. (2002) 'Performance assessment of the lead user idea-generation process for new product development', *Management Science*, 48 (8), pp. 1042-1059.

Lombard, M., Snyder-Duch, J., Bracken, C. (2002) 'Content Analysis in Mass Communication: Assessment and Reporting of Intercoder Reliability', in *Human Communication Research*, 28 (4), pp. 587–604.

Louridas, P. (1999) 'Design as bricolage: anthropology meets design thinking', *Design Studies*, 20 (6), pp. 517-535.

Lund, V., Hemlin, S., and Lockeretz, W. (2002) 'Organic livestock production as viewed by Swedish farmers and organic initiators', *Agriculture and Human Values*. 19, pp. 255–268.

Lundvall, B. and Johnson, B. (1994) 'The Learning Economy', *Journal of Industry Studies*, 1(2) pp. 23-42.

Lüthje, C. and Herstatt, C. (2004) 'The Lead User method: an outline of empirical findings and issues for future research', *R&D Management*, 34 (5), pp. 553-568.

Lüthje, C., Herstatt, C. and von Hippel, E. (2005) 'User-innovators and "local" information: The case of mountain biking', *Research Policy*, 34, pp. 951–965.

Macken-Walsh, A. (2009) *Barriers to Change: A Sociological Study of Rural Development in Ireland*. Teagasc Rural Economy Research Centre Working Paper Series. Available at: <http://teagasc.ie/handle/11019/848> (Accessed 15.6.17).

Macken-Walsh, A., Crosson, P., and Murray, A. (2012) *A qualitative study of Irish beef farmers' production decisions: summary and implications for extension*. Teagasc: Oak Park, Carlow.

Madsen-Østerbye J. (2014) *AKIS and advisory services in Denmark. Report for the AKIS inventory (WP3) of the PRO AKIS project*. Available at: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwik2eXsqJvVAhVID8AKHVXxDJUQFggoMAA&url=http%3A%2F%2Fwww.proakis.eu%2Fsites%2Fwww.proakis.eu%2Ffiles%2FCountry%2520Report%2520Denmark%252006%252006%25202014.pdf&usg=AFQjCNHQhbpC-Nz9EkJQenqnTkf_y_avPw (Accessed 29.6.17)

Marra, M., Pannell, D. and Ghadim, A. (2003) 'The economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve?' *Agricultural Systems*. 75 pp. 215–234.

Marshall, M.N.

(1996a) 'The Key informant Technique', *Family Practice*, 13 (1), pp. 92-97.

(1996b) 'Sampling for qualitative research', *Family Practice*, 13 (6), pp. 552-525.

Mason, J.

(2011) 'Facet Methodology: the case for an inventive research orientation', *Methodological Innovations*. Online. 6(3) pp. 75-92. DOI: 10.4256/mio.2011.008.

(2006) 'Mixing methods in a qualitatively driven way', *Qualitative Research*. 6 (9) pp. 9-25.

Mauthner, N. and Doucet, A. (2003) 'Reflexive accounts and accounts of reflexivity in qualitative data analysis', *Sociology*, 37(3), pp. 413-431.

Maxwell, J. (2010) 'Using Numbers in Qualitative Research', *Qualitative Inquiry*. 16 (6) pp. 475-482.

McDonald, R., Macken-Walsh, A., Pierce, K., and Horan, B. (2014) 'Farmers in a deregulated dairy regime: Insights from Ireland's New Entrants Scheme' *Land Use Policy*. 41, pp. 21–30.

McDonagh, J. (2001) *Renegotiating Rural Development in Ireland*. Aldershot: Ashgate.

McElwee, G. (2006) 'The Enterprising Farmer: A Review of Entrepreneurship in Agriculture', *Royal Agricultural Society of England Journal*, pp. 66-75.

McFadden, T. and Gorman, M. (2016) 'Exploring the concept of farm household innovation capacity in relation to farm diversification in policy context', *Journal of Rural Studies*. 46, pp. 60-70.

McLeod, J. (2005) 'Feminists re-reading Bourdieu: Old debates and new questions about gender habitus and gender change', *School Field*, 3(1), pp.11-30.

- Menguc, B., Auh, S. & Yannopoulos, P. (2014) 'Customer and supplier involvement in design: The moderating role of incremental and radical innovation capability', *Journal of Product Innovation Management*, 31 (2), pp. 313-328.
- Mezirow, J. (1991) *Transformative dimensions of adult learning*. San Francisco: Jossey-Bass.
- Morgan, K. and J. Murdoch (2000). 'Organic vs. conventional agriculture: knowledge, power and innovation in the food chain', in *Geoforum* 31 (2) pp. 159-173.
- Morgan, S. (2011): 'Social Learning among Organic Farmers and the Application of the Communities of Practice Framework', *The Journal of Agricultural Education and Extension*, 17 (1) pp. 99-112.
- Morgan, S., Marsden, T., Miele, M. and Morley, A. (2010) 'Agricultural multifunctionality and farmers' entrepreneurial skills: A study of Tuscan and Welsh farmers', *Journal of Rural Studies*. 26, pp. 116-112.
- Mormont, M. (2003) 'What is rural about?' in Blanc, M. (ed.) *Innovations, Institutions and Rural Change*. Luxembourg: Office for Official Publications of the European Communities, pp. 19-49. Available at: <http://bookshop.europa.eu/en/cost-action-a12-pbKINA20504/> (Accessed 8.7.17).
- Mulgan, G. (2006) 'The Process of Social Innovation', *Innovations*. Spring, pp. 145-162.
- Murray, R., Caulier-Grice, J. and Mulgan, G. (2010) *The Open Book of Social Innovation*. London: NESTA.
- Navarro, Z. (2006) 'In Search of a Cultural Interpretation of Power: The Contribution of Pierre Bourdieu', *IDS Bulletin*. 37 (6) pp. 11-22.
- Nemet, G. (2009) 'Demand-pull, technology-push, and government-led incentives for non-incremental technical change', *Research Policy*, 38 (5), pp. 700-709.
- Neumeier, S. (2012) 'Why do social innovations in rural development matter and should they be considered more seriously in rural development research?', *Sociologia Ruralis*, 52(1), pp.48-69.
- Norman, D. A., and Verganti, R. (2014) 'Incremental and radical innovation: Design research vs. technology and meaning change', *Design Issues*, 30(1), pp. 78-96.
- OECD/FAO (2016) *OECD-FAO Agricultural Outlook 2016-2025*, OECD Publishing, Paris. Available at: http://dx.doi.org/10.1787/agr_outlook-2016-en (Accessed 17.7.17).
- O'Flynn, P. (2012) *Rural Identity and Protest Mobilisation: the case of the Turf Cutters and Contractors Association*, unpublished MA Thesis, Galway, National University of Ireland.
- O'Gorman, C. (2015) 'The study of entrepreneurship in Ireland', *The Irish Journal of Management*, 34 (1), pp. 7-21.
- O'Gorman, C., Curran, D., Heanue, K. and Meredith, D. (2012) 'The Intent of Farmers to Start a New Enterprise', *Proceedings of the Irish Academy of Management Conference*, National University of Ireland Maynooth, September 6-7. Available at: <http://iamireland.ie/annual-conference/conference-proceedings/2012-nuim.html> (Accessed 7.7.17).

The Open University (no date) *Research Ethics at the Open University: Human Research*. [Online]. Available at: <http://www.open.ac.uk/research/ethics/> (Accessed 8.7.17).

Oreszczyn S., Lane A. and Carr, S. (2010) 'The role of networks of practice and webs of influencers on farmers' engagement with and learning about agricultural innovations', *Journal of Rural Studies* 26, pp. 404-417.

Oreszczyn, S. and Lane, A. (2012). 'Agri-environmental knowledge management and networks of practice: a workshop background paper', *Hedgerow Futures Conference*, 3-5 September 2012, Staffordshire University, Stoke on Trent.

Packard, B. and Conway, P. (2006) 'Methodological Choice and Its Consequences for Possible Selves Research', *Identity: An International Journal of Theory and Research*, 6 (3), pp. 251-271.

Packham, R., Petheram, J., and Murray-Prior, R. (2007) 'A Farming Systems Research (FSR) as a Platform for RD&E in Agriculture and NRM', *APEN Forum* (Vol. 7), pp. 77-99. Available at: [http://www.apen.org.au/images/PDF%20documents/APEN%20Forum07%20papers/Packham_Petheram_Prior_A_Farming_Systems_Research_\(FSR\)_As_a_Platform_for_RDE_in_Agriculture_and_NRM.pdf](http://www.apen.org.au/images/PDF%20documents/APEN%20Forum07%20papers/Packham_Petheram_Prior_A_Farming_Systems_Research_(FSR)_As_a_Platform_for_RDE_in_Agriculture_and_NRM.pdf) (Accessed 15.6.17).

Pahl, G., Beitz, W., Feldhusen, J and Grote K-H. (2007) *Engineering design: a systematic approach*. 3rd edn. Springer: London.

Peine, P. (2011) 'Challenging Incommensurability: What We Can Learn from Ludwik Fleck for the Analysis of Configurational Innovation', *Minerva*, 49, pp. 489-508.

Pelling, M., High, C., Dearing, J., and Smith, D. (2008) 'Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organisations', *Environment and Planning A*, 40 (4), pp. 867-884.

de Pillis, E. and Reardon, K. (2007) 'The influence of personality traits and persuasive messages on entrepreneurial intention: A cross-cultural comparison', *Career Development International*, 12(4), pp. 382-396.

van der Ploeg, J.D., Bouma, J., Rip, A., Rijkenberg, F.H.J., Ventura, F. & Wiskerke, J.S.C. 'On Regimes, Novelties and Co-production' in: Wiskerke, J.S.C. & Van Der Ploeg, J.D. (Eds.) (2004) *Seeds Of Transition*. Assen: Van Gorcum.

Polanyi, M. (1962) 'Tacit Knowing: Its Bearing on Some Problems of Philosophy', *Reviews of Modern Physics*, 34 (4), pp. 601-616.

Portes, A. (1998) 'Social Capital: Its Origins and Applications in Modern Sociology', *Annual Review of Sociology*. 24, pp. 1-24.

Power, E. (1999) 'An Introduction to Pierre Bourdieu's Key Theoretical Concepts', *Journal for the Study of Food and Society*. 3 (1), pp. 48-52.

Practical Farm Ideas magazine: <http://www.farmideas.co.uk/> (Accessed 6.7.17).

Prager, K. and Thomson, K. (2014) *AKIS and advisory services in the Republic of Ireland*. Report for the AKIS inventory (WP3) of the PRO AKIS project. Online resource: www.proakis.eu/publicationsandevents/pubs (Accessed 6.7.17).

PROLINNOVA website: <http://www.prolinnova.net/> (Accessed 6.7.17).

Putnam, R. (1995) 'Bowling alone: America's declining social capital', *Journal of Democracy*, 6 (1), pp. 64-78.

Rajalahti, R., Janssen, W. and Pehu, E. (2008) *Agricultural Innovation Systems: From Diagnostics toward Operational Practices*. Washington, DC: The World Bank.

Riggs, W. and von Hippel, E. (1994) 'Incentives to innovate and the sources of innovation: the case of scientific instruments', *Research Policy*, 23 (4), pp.459-469.

Riley, M. and Harvey, D. (2007) 'Oral histories, farm practices and uncovering meaning in the countryside', *Social and Cultural Geography*, 8 (3). pp. 391-415.

Risgaard, M-L., Frederiksen, P. and Kaltoft, P. (2007) 'Socio-cultural processes behind the differential distribution of organic farming in Denmark: a case study', *Agriculture and Human Values*, 24, pp. 445–459.

Rivera, W. M., Qamar, K., and Mwandemere, H. K. (2005) *Enhancing Coordination among AKIS/RD Actors: An analytical and comparative review of country studies on agricultural knowledge and information systems for rural development (AKIS/RD)*. FAO: Rome.

Roberts, J. (2006) 'Limits to communities of practice', *Journal of Management Studies*, 43(3), pp.623-639.

Rogers, E.

(2003) *Diffusion of Innovations*, 5th edn. New York: Free Press.

(2002) 'The Nature of Technology Transfer', *Science Communication*, 23 (3), pp. 323-341.

Rogers, M. (2012) 'Contextualizing theories and practices of bricolage research', *The Qualitative Report*, 17 (48), pp.1-17.

Röling, N. and Engel, P. (1990) 'Information technology from a knowledge system perspective: Concepts and issues', *Knowledge, Technology and Policy*, 3(3), pp. 6-18.

Roseneil, S. (2012) 'Using biographical narrative and life story methods to research women's movements: FEMCIT', *Women's Studies International Forum*, 35 (3), pp. 129-131. Available at: <http://eprints.bbk.ac.uk/4708/> (Accessed 14.7.17).

Russell, D. and Ison, R. (2000) 'The research–development relationship in rural communities: an opportunity for contextual science', in Ison, R. and Russell, D. (Eds.) *Agricultural Extension and Rural Development: Breaking Out of Traditions*. Cambridge University Press: Cambridge. pp. 10-29.

Saad, N. (2002) *Farmer Processes of Experimentation and Innovation, a Review of the Literature*. Working Document No. 21. Cali, Colombia: CGIAR Systemwide Program on Participatory Research and Gender Analysis.

Sapsford, R. (2007) *Survey Research*. 2nd edition. London: SAGE.

Sathe, V. (1989) 'Fostering entrepreneurship in the large, diversified firm', *Organizational Dynamics*, 18(1), pp. 20-32.

Schaffers, H.; Guerrero Cordoba, M.; Hongisto, P.; Kallai, T.; Merz, C. and van Rensburg, J. (2007) 'Exploring business models for open innovation in rural living labs', *13th International Conference on Concurrent Enterprising*, Sophia-Antipolis, France, 4-6 June 2007, pp. 13. Available at: <http://hdl.handle.net/10204/1583> (Accessed 6.7.17).

Scheer, M. (2012) 'Are Emotions a Kind of Practice (and Is That What Makes Them Have a History)? A Bourdieuan Approach to Understanding Emotion', *History and Theory*, 51, pp. 193-220.

Schiebel, W. (2002) *Entrepreneurial personality traits in managing rural tourism and sustainable business*. Agrarmarketing Aktuell, 6(3), pp. 85–99.

Schön, S., Kumar, S. and Ebner, M. (2014) *The Maker Movement. Implications of new digital gadgets, fabrication tools and spaces for creative learning and teaching*. Available at: http://scholar.google.co.uk/scholar_url?url=https://www.openeducationeuropa.eu/sites/default/files/asset/Learning%2520in%2520cyber-physical%2520worlds%20In-depth%2039%202%200.pdf&hl=en&sa=X&scisig=AAGBfm39ZJ3vYltra3nLhh4JT2ivDUHMPQ&nossl=1&oi=scholar&ved=0ahUKEwjYndCDq5vVAhVKCcAKHYucAPYQgAMllygAMAA (Accessed 8.7.17).

Schumpeter, J. (1943) *Capitalism, Socialism and Democracy*. London: George Allen and Unwin Ltd.

Schwartz, B. et al. (2002) 'Maximizing Versus Satisficing: Happiness Is a Matter of Choice', *Journal of Personality and Social Psychology*, 83 (5) pp. 1178–1197.

Scoones, I., Thompson, J. and Chambers, R. (2008) *Workshop Summary: Farmer First Revisited*. University of Sussex, December 2007. Available at [http://www.future-agricultures.org/farmerfirst/files/Farmer First Revisited Post Workshop Summary Final.pdf](http://www.future-agricultures.org/farmerfirst/files/Farmer%20First%20Revisited%20Post%20Workshop%20Summary%20Final.pdf) (Accessed 8.7.16).

Scott, J. (1990) *A Matter of Record*. Cambridge: Polity.

Seuneke, P., Lans, T. and Wiskerke, J. (2013) 'Moving beyond entrepreneurial skills: Key factors driving entrepreneurial learning in multifunctional agriculture', *Journal of Rural Studies*, 32, pp. 208- 219.

Shah, S and Tripsas, M.

(2016) 'When Do User-innovators Start Firms? A Theory of User Entrepreneurship', in Harhoff, D. and Lakhani, K. (eds.) *Revolutionizing Innovation: Users, Communities, and Open Innovation*. Cambridge, Massachusetts: The MIT Press, p.285-307.

(2007) 'The Accidental Entrepreneur: The Emergent and Collective Process of User Entrepreneurship', *Strategic Entrepreneurship Journal*, 1 (1-2), pp. 123–140.

Shutes, M. (2003) 'Real Milk from Mechanical Cows: Invention, Creativity and the Limits of Anthropological Knowledge', in Davies, M. and Meskimmon, M. (eds.) *Breaking the Disciplines: Reconceptions in Knowledge, Art and Culture*. I.B. Tauris and Co. Ltd: London. pp. 61-83.

- Silverman, D. (2000) *Doing Qualitative Research: A Practical Handbook*. London: SAGE Publications Ltd.
- Sligo, F. and Massey, C. (2007) 'Risk, trust and knowledge networks in farmers' learning', *Journal of Rural Studies* 23 pp. 170–182.
- SLIM, The SLIM Project (2004) *Social Learning as a Policy Approach for Sustainable Use of Water. A field tested-framework for observing, reflecting and enabling*, SLIM (Social Learning for the Integrated Management and Sustainable Use of Water at Catchment Scale) Framework. Available at: <https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxzbGltc29jaWFsbGVhcm5pbmdmb3Jpd218Z3g6MzlyZTFhYzEONTM0MzhI> (Accessed 14.6.17).
- Smyth, G.
- (2012) 'Irish national identity after the Celtic Tiger'. *Estudios Irlandeses*, 7, pp. 132-137.
- (2001) *Space and the Irish Cultural Imagination*. Basingstoke: Palgrave.
- Social Research Association (nd) *Code of Practice for the Safety of Social Researchers*. Available at: http://the-sra.org.uk/wp-content/uploads/safety_code_of_practice.pdf (Accessed 23.6.17).
- Society of Chartered Surveyors Ireland and Teagasc (2015) *Land Market Review and Outlook 2016*. Available at: <https://www.teagasc.ie/media/website/publications/2016/SCSI-Land-Market-Review-2016.pdf> (Accessed 12.6.17).
- Sociological Association of Ireland (nd) *Ethical Guidelines*. Available at: http://www.sociology.ie/uploads/4/2/5/2/42525367/sai_ethical_guidelines.pdf (Accessed 12.6.17)
- Spielman, D., Davis, K., Negash, M. and Ayele, G. (2011) 'Rural innovation systems and networks: findings from a study of Ethiopian smallholders', *Agriculture and Human Values*, 28(2), pp. 195-212.
- SREAS. (nd) *The Swedish Rural Economy and Agricultural Societies*. Available at: <http://www.hush.se/?p=12286> (Accessed 8.7.17).
- Stringer, L., and Reed, M. (2007) 'Land degradation assessment in southern Africa: integrating local and scientific knowledge bases', *Land Degradation & Development*, 18 (1), pp. 99-116.
- Strumsky, D. and Lobo, J. (2015) 'Identifying the sources of technological novelty in the process of invention', *Research Policy*, 44 (8), pp.1445-1461.
- Sullivan, A. (2002) 'Bourdieu and education: How useful is Bourdieu's theory for researchers?', *Netherlands Journal of Social Sciences*, 38(2), pp.144-166.
- Sumberg, J., Heirman, J., Raboanarielina, C. and Kaboré, A. (2013) 'From agricultural research to 'product development': What role for user feedback and feedback loops?' *Outlook on Agriculture*, 42 (4) pp 233–242.
- Sumberg, J., Okali, C. and Reece, D. (2003) 'Agricultural research in the face of diversity, local knowledge and the participation imperative: theoretical considerations', *Agricultural Systems*, 76, pp. 739–753.

Sumner, A. (2008) *Moral Ambiguity, Quantum Leaping and Being Well: The Next 30 Years of Development Studies?* Working Paper, Development Studies Association Conference, UK. Available at: https://scholar.google.co.uk/scholar?hl=en&newwindow=1&q=MORAL+AMBIGUITY%2C+QUANTUM+LEAPING+AND+BEING+WELL&btnG=&lr=lang_en&as_sdt=1%2C5 (Accessed 9.9.16).

Sutherland, L-A. (2013) 'Can organic farmers be 'good farmers'? Adding the 'taste of necessity' to the conventionalization debate', *Agriculture and Human Values*, 30, pp. 429–441.

Sutherland, L-A. and Burton, R. (2011) 'Good Farmers, Good Neighbours? The Role of Cultural Capital in Social Capital Development in a Scottish Farming Community', *Sociologia Ruralis*. 51 (3) pp. 238-255.

Teagasc:

(2017) *Statement of Strategy 2017-2020*. Available at: <https://www.teagasc.ie/publications/2017/teagasc-statement-of-strategy-2017-2020.php> (Accessed 18.7.17).

(2016) *Teagasc Technology Foresight 2035*. Available at: <https://www.teagasc.ie/publications/2016/teagasc-technology-foresight-2035---final-report.php> (Accessed 16.6.17).

Tongco, M. (2007) 'Purposive sampling as a tool for informant selection', *Ethnobotany Research and Applications*, 5, pp. 147-158. Available from <http://hdl.handle.net/10125/227> (Accessed 8.7.17)

Tovey, H.

(2009a) 'Ireland: Ecologising Rural Ireland? Conflicts and Contradictions Regarding Knowledge for Sustainable Development', in Bruckmeier, K. and Tovey, H. (eds.) *Rural Sustainable Development in the Knowledge Society*, Farnham: Ashgate. pp. 131-150.

(2009b) 'Managing Rural Nature: Regulation, Translations and Governance in the Republic of Ireland and Northern Ireland', in McDonagh, J., Varley, T. And Shortall, S. (eds.) (2009) *A Living Countryside? The Politics of Sustainable Development in Rural Ireland*, Aldershot: Ashgate. pp. 107-122.

Tovey, H. and Mooney, R. (2006) *Citizens and Governance in a Knowledge Based Society*. Available at: <http://cordis.europa.eu/documents/documentlibrary/127030001EN6.pdf> (Accessed 8.7.17).

Tremblay, M. (1957) 'The key informant technique: A nonethnographic application', *American Anthropologist*, 59(4), pp. 688-701.

UK: Department for Environment, Food and Rural Affairs (2014) *Farming Statistics: Final Land Use, Livestock Populations and Agricultural Workforce at 1 June 2014 – England*. Available at: <https://www.gov.uk/government/statistics/farming-statistics-final-land-use-livestock-populations-and-agricultural-workforce-as-at-1-june-2014-england> (Accessed 12.7.17).

(2007) *Eleven Lessons: Managing Design in Eleven Global Companies - Desk Research Report*. Design Council: London.

(2006) *Eleven Lessons: Managing Design in Eleven Global Companies – A Study of the Design Process*. Design Council: London.

Vanclay, F. (2004) Social principles for agricultural extension to assist in the promotion of natural resource management. *Animal Production Science* 44 (3), pp. 213-222.

Vanclay, F., Howden, P., Mesiti, L. and Glyde, S. (2006) 'The social and intellectual construction of farming styles: testing Dutch ideas in Australian agriculture', *Sociologia Ruralis*, 46(1), pp. 61-82.

Vanclay, F., Mesiti, L. and Howden, P. (1998) 'Styles of Farming and Farming Subcultures: Appropriate concepts for Australian rural sociology?', *Rural Society*. 8(2), pp.85-107.

van der Veen, M. (2010) 'Agricultural innovation: invention and adoption or change and adaptation?', *World Archaeology*. 42(1), pp. 1-12.

Varley T.

(2010) 'On the Road to Extinction: Agrarian Parties in Twentieth-Century Ireland', *Irish Political Studies*, 25 (4), pp. 581-601.

(2009) 'Populism and the Politics of Community Survival in Rural Ireland', in McDonagh, J., Varley, T. and Shortall, S. (eds.) (2009) *A Living Countryside? The Politics of Sustainable Development in Rural Ireland*. Aldershot: Ashgate, pp. 341-360.

von Hippel, E.

(2017) *Free Innovation*. Cambridge, MA: MIT Press. Available at: <http://hdl.handle.net/1721.1/105282> (Accessed 6.6.17).

(2007) 'Horizontal innovation networks – by and for users', *Industrial and Corporate Change*, 16 (2), pp. 293-315.

(2005) *Democratizing Innovation*. Cambridge, Mass: The MIT Press.

(1987) 'Cooperation between rivals: Informal know-how trading', *Research Policy*, 16(6), pp.291-302.

(1977) 'Transferring Process Equipment Innovations from User-Innovators to Equipment Manufacturing Firms', *R&D Management*. 8 (1), p. 13–22.

(1976) 'The dominant role of users in the scientific instrument innovation process', *Research Policy*, 5 (3), pp. 212-239.

von Hippel, E., Ogawa, S. and De Jong, J. (2011) 'The Age of the Consumer-Innovator', *MIT Sloan Management review*. 53 (1).

Webb, E., Campbell, D., Schwartz, R. and Sechrest, L. (1966) *Unobtrusive Measures: Non-Reactive Measures in the Social Sciences*. Chicago: Rand McNally.

Wenger, E.

(2011) *Communities of Practice: A Brief Introduction*. Available at: <https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/11736/a%20brief%20introduction%20to%20cop.pdf?sequence=1> (Accessed 8.7.17).

(2010) 'Communities of practice and social learning systems: the career of a concept'. Available at: <http://wenger-trayner.com/wp-content/uploads/2012/01/09-10-27-CoPs-and-systems-v2.0.pdf> (Accessed 14.7.17)

(2000) 'Communities of Practice and Social Learning Systems', *Organization*. 7(2) pp. 225-246.

(1998) *Communities of Practice: Learning, Meaning and Identity*. Cambridge, UK: Cambridge University Press.

Wengraf, T. (2001) *Qualitative Research Interviewing*. London: Sage Publications.

Wengraf, T. with Chamberlayne, P. (2013) 'Biography-using Research (BNIM), Sostris, Institutional Regimes, and Critical Psycho-Societal Realism', in Turk, J., and Mrozowicki, A. (Eds.) (2013) *Realist Biography and European Policy: An Innovative Approach to European Policy Studies*. Leuven University Press. pp. 63-92.

Wettasinha, C. and Waters-Bayer, A. (eds.) (2010). *Farmer-led joint research: experiences of PROLINNOVA partners*. A booklet in the series on Promoting Local Innovation (PROLINNOVA). Silang, Cavite, Philippines: IIRR / Leusden, Netherlands: PROLINNOVA International Secretariat.

World Bank (2006) *Linking Agricultural Innovations to Knowledge Sharing in Africa*. IK Notes 88. Available at: <http://documents.worldbank.org/curated/en/171141468008449633/Linking-agricultural-innovations-to-knowledge-sharing-in-Africa> (Accessed 8.7.17).

Wu, B, and Pretty, J. (2004) 'Social connectedness in marginal rural China: The case of farmer innovation circles in Zhidan, north Shaanxi', *Agriculture and Human Values*. 21. pp. 81–92.

Yang, Y. (2014) 'Bourdieu, Practice and Change: Beyond the Criticism of Determinism', *Educational Philosophy and Theory*, 46(14), pp.1522-1540.

Yin, R. (2014) *Case study research: design and methods*. 5th edn. London: SAGE.

Bibliography – Wider reading

Banks, R. (2016) *The Shepherd's Life: A Tale of the Lake District*. London: Penguin Random House.

Kavanagh, P. (1948) *Tarry Flynn*. 1972 edn. London: Penguin.

MacDonald, H. (2014) *H is for Hawk*. London: Penguin Random House UK.

McGahern, J. (2002) *That They May Face the Rising Sun*. 2003 edn. London: Faber and Faber Ltd.

Ryan, D. (2013) *The Thing about December*. 2014 edn. London: Penguin Random House.